BACKGROUND TO GEOGRAPHY

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By

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TO MY WIFE

HELEN

IN RESPONSE TO A CHALLENGE.

Preface

THIS book is an attempt to interest the general reader in the study of geography, and to explain the value of a geographical outlook on the world today. I am aware of the dangers of such an undertaking, and hope that my efforts to simplify so wide and varied a subject have not resulted in misleading generalizations. It is emphatically *not* a *textbook* though I believe that as a commentary it may be read with some profit by those preparing for entrance to a university. If the book also induces readers to inquire further into some aspect of geography, its main purpose will have been achieved. Many of the statements no doubt require qualification, but I have omitted such phrases as "in general," "with some exceptions," and so forth. The book is an introduction, and further study should bring home to the reader the necessity for more detailed enquiry.

A number of sketch maps and diagrams have been included; these are also generalizations, and the reader must have a good atlas to hand. Several are listed in the appendix.

It would be difficult to name here all those to whom the book owes whatever merits it may possess. The list of books for further reading indicates some of my indebtedness. I should like, however, to record the names of four scholars particularly; the late George Gordon Coulton, formerly Fellow of St. John's College, Cambridge, who taught me how a past age could be brought to life and related to modern problems; the late Professor A. G. Ogilvie, for personal kindnesses and encouragement; Marcel Aurousseau, a former colleague and a friend from whom I have learnt much; and T. W. Freeman, a friend of many years standing with whom at various times I have discussed some themes of this book.

I am also indebted to Mr. Frank George for helpful comments. The opinions expressed in it are personal, and if there are errors, they are not to be attributed to them or to any one but myself.

Finally I am again obliged to Miss Alison Usher for typing the greater part of the manuscript accurately and efficiently.

G. R. CRONE

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Sketch-maps and Diagrams

CHAPTER ONE

Introduction: the Medieval Outlook

In the pages which follow, an attempt is made to explain what modern geography is about, how the subject has reached its present position, and what it can contribute to an understanding of the world today. At the same time it is hoped that the reader will derive from them a realization of the great interest, and even entertainment, which can be obtained from its study. Some may consider that geographers are indulging in so many and so varied activities that it is difficult to discover what their aim is. That there is an underlying unity, based upon clearly defined principles and methods, is one theme of this book. It is only fair to add that many geographers will probably differ from views expressed in it. But, within limits, that is part of the interest of geography; I hope, that when the reader has read these pages, he or she will be in a position to form an opinion on this, or better still, will feel stimulated to carry the study further. This is the point of view of one geographer only, who is well aware that it is not the whole story.

In the opening chapters some account is given of what geographers have thought and written in the past. These are followed by chapters on the content of modern geography. Finally some concrete examples of its application to modern problems are given. This approach is primarily historical, but it can be justified. Speaking broadly, medieval geographers may be compared with the present-day citizen, who gives little thought to the world outside his own immediate environment. What views he has are probably an amalgam of imperfectly understood, or sensational, scraps from the popular press or radio, mixed with vague recollections from his school days and coloured perhaps by prejudices of various kinds. I well remember a pupil teacher many years ago telling me of his astonishment at the methods employed by his colleague.

On his class being unable to name two towns in France, he exhorted them—"Remember the sailor's trousers!" Whereupon they shouted in unison—"Toulouse and Toulon!" Times have changed, but this kind of trick is not entirely dead—to judge by some radio quiz programmes. The ordinary men of the Renaissance may be likened tentatively to the somewhat more informed public, genuinely interested in the world but often puzzled by what they read or hear, and without a key to relate the stream of facts to each other or unable to visualize a coherent picture of the contemporary world, upon which, to put it at its lowest, their daily livelihood depends. The point of the third category of this analogy does not require to be laboured. The modern geographer has his contribution to make to an understanding of the modern world, while fully aware that it is not the only one. If a further reminiscence is permissible, I recall the answer of a distinguished geographer to my inquiries about the attitude to geography in the early days of this century: "We were so astonished to discover that geography made sense at all that we gave no further thought to theories!"

Geography is one of the oldest subjects, and from the time of the Greeks and the Romans it has attracted the attention of scholars, statesmen, and men of affairs, and the literature on it is vast. I do not propose in this outline to begin with the Greeks, partly because that would entail specialist study, but principally because, from medieval times onwards, its story develops uninterruptedly, from almost complete neglect to its present world-embracing outlook. We are likely to overlook how circumscribed was the world of western medieval man before the Renaissance. Throughout most of the centuries between the decline of Rome and the fall of Constantinople, the peoples of Christendom were fighting for their very existence. At various times, they were harried and ravaged by sea raiders from the north, by nomads from the eastern steppes, and by the fanatical power which emerged from the deserts of south-west Asia. From the west alone came no direct threat, but there the boundary was the great ocean, impassable with the ships and technical equipment at their disposal. It was no accident that it was in this quarter that they eventually broke out of their confined homelands on

the western margins of Eurasia. Beyond the bounds of Christendom were strange lands and peoples, with whom their contacts were intermittent and often hostile. It is not strange that their beliefs about the outside world were fantastic to our way of thinking, or that they placed in these wide shadowy spaces the distorted scraps of authentic information which had come down to them from a more spacious world, or peopled them with the wondrous figures of legend and folklore. As their contacts with this world increased, it was to be expected that they should attempt to reconcile new information with old legend, to produce very often even more fantastic tales. Since Africa was the forbidden continent, most of these found a home there—the men "whose heads do grow beneath their shoulders," those who had one leg only, the people whose bloody lower lips hung down on their chests, the gold-digging ants of the Niger basin, all these find a home in the medieval world map. It is possible, but no doubt dangerous, to explain these stories as misunderstood reports of actual peoples; the "heads beneath the shoulders" may reflect a practice similar to that of the later "veiled Tuareg"; the Shilluk people of the Sudan are accustomed to stand on one leg for long periods; the great lips recall the lip-rings of West Africa; and the gold-digging ants were probably the negroes who obtained alluvial gold by burrowing into the ground. However this may be, one should not reject off-hand these medieval tales.

The descriptions of the world by men like Sir John Mandeville are often regarded as valueless collections of tall stories and their authors as unduly credulous or downright liars. This is to judge them out of their time; they were giving the best account of the world they could from the material available, and in a number of instances they incorporate pieces of first-hand information gleaned from their contemporaries. The description of the world by an anonymous Franciscan written about A.D. 1350, for example, contains references to a friar who accompanied a voyage along the coast of north-west Africa, and to the activities of missionary friars on the White Nile. The Navigations of the Irish Saint Brandon, some centuries earlier, are admittedly to be treated with caution and present problems of chronology, but even if they are accepted only as reflecting knowledge of the Norse voyages to Greenland,

it is interesting to see how natural phenomena have been transformed in the telling: the column of shining crystal may well be icebergs and the thick curdled sea pack-ice; the blazing island with obnoxious fumes suggests volcanic action; and the great fishes in the clear water were perhaps seen in Greenland fiords or on the Newfoundland banks. All these features could be located in the North Atlantic basin. It was only natural that unlettered travellers should interpret what they saw in terms of their limited experience. A pilgrim watching the clouds, which foretold the onset of the rains in the eastern Mediterranean, rolling round the mountain-tops, might believe them to be the manifestation of spirits, but another was capable of drawing a comparison between the dunes of the sand desert and the waves of the sea.

In discussing the medieval attitude to monsters, signs and portents, two points should be remembered. It was believed that creation was spontaneous; animals, for example, might be generated at any place and at any time. Consequently, it was no argument to say that, since no one had ever seen a certain monster in his own country, it could not exist somewhere else in the world. The teaching of the Church also lent support to the notion of monsters, and belief in them in certain situations was approved by St. Augustine, since the Creator is all-powerful.

It is often stated that the idea of a round earth was heretical to the medieval man, and, in fact, that it had passed out of mind. It is true that it was difficult to reconcile it literally with many scriptural texts, but the theory never died out entirely. For one thing, what astronomical knowledge survived was based upon the sphericity of the earth. In a number of ways the teaching of the Church Fathers was justified in the event. In the argument as to whether the lands assumed to exist beyond the Equator could be reached and would be found to be inhabited, they asserted that they were, since the world was peopled from one centre by the sons of Ham, Shem and Japhet, and the faithful had been ordained to carry the Gospel into every corner of the earth.

These speculations on the nature of the world had little practical influence through most of the period, but it was certainly not a period of stagnation. The Crusades, for ex-

ample, were a considerable stimulus to technological advance and to intellectual discussion. It is not possible here to give a comprehensive account of their effects upon the rising nations of the West, but several points should be noted; the acquaintance of the West with a region in strong contrast to any they had previously known; the stimulus to trade, despite frequent hostilities; the acquisition of new techniques and skills for everyday life; the recovery of part of the learning of Greece through translations from the Arabic; contact with a civilization in a number of respects more sophisticated, which forced upon them the realization that there were other ways of life than their own. The Crusading period was thus the first step in European expansion throughout the world. What this world was like was also brought home to them by another stimulating event, the composition of that remarkable work known briefly as the *Travels of Marco Polo*. This revealed to the West the vast extent of Asia, the manifold variety of its peoples and the existence of the ancient and highly developed civilization of China. Though the work is cast in the form of a narrative, modern scholarship has shown that the *Travels* are in fact an attempt at a systematic geography of Asia. It is clear that Marco is not writing at first hand in every chapter but has assembled the best evidence available to him; this seems to be true of his account of the Indian Ocean. Though composed at the beginning of the fourteenth century, it had no great immediate effect, and did not rival the more entertaining and less authentic compilation of a Mandeville. But later, in the fifteenth century, it supplied Columbus with considerable, but antiquated, support for his enterprise. The project of "reaching the East by the West," i.e. reaching eastern Asia by sailing westwards across the Atlantic, illustrates clearly one facet of medieval learning. There is quite considerable evidence that Columbus's plan was by no means new. At least one hundred years earlier it had stirred the imagination of scholars and rulers. While they considered the plan feasible, they were forced to admit that it was beyond their competence for the time being. Mandeville pointed out trenchantly that its execution depended upon having an adequate ship, suitably provisioned. The event had therefore to wait upon the development of ship

construction and navigation. This situation—theoretical progress, hamstrung by technical difficulties—can be traced in other departments. Astronomers were aware that it was possible to determine the difference in longitude between two places, and thence their distance apart, by comparing the local time at which an astronomical event (an eclipse of the moon, for instance) was observed at the two places. But the lack of efficient timepieces and of accurate astronomical tables rendered this method useless until these became available in the eighteenth century. None the less, the application of science to practical affairs was making slow progress. The first large and successful advance was made for the use of seamen. To modern eyes the early medieval marine charts (generally known as portolan charts) may not appear accurate or of great use, but in fact they were effective in the conditions for which they were designed, that is the Mediterranean Sea. They set a precedent in being based on scientific data, observations of bearings by the mariner's compass, the determination of distances from the motion of the ship, and the recording of a mass of facts—shoals, rocks, harbours—by standardized conventional signs. With the exception of contemporary itineraries on land and some tentative efforts at mapping, they may be regarded at the first scientific tools of the geographer. This progress reflects the growth of more stable conditions in the late medieval centuries and the development of trade, especially in the Mediterranean, a progress which eventually made possible the pioneer voyages of discovery.

Medieval man, to generalize broadly, regarded the world outside rather narrow limits as a shadowy region in which anything might, or could happen. In a sense, the improbable was more acceptable to his imagination than the rational. Even within the familiar world around him, he had scarcely begun to sort out and arrange the innumerable facts and events of everyday occurrence, much less to explain them. What explanations were necessary were to be found in Holy Writ. The established order was accepted and regarded as eternal, though in the earlier centuries speculation about the future or the desire for change was profitless, since many believed that the world was destined to end in the year A.D. 1000. Geography in any profound sense received little

attention; its literature was either strictly practical—lists of stages on the pilgrimage to Jerusalem, or on royal progresses through the kingdom, collections of traditional wisdom for farmers and shepherds, lists of ports liable to dues and similar *ad hoc* compilations, or the collections of wonders mentioned above, strictly for edification or amusement.

The effect of overseas expansion was to shatter this mould; the seamen showed decisively that every sea was navigable and every continent inhabitable. Slowly and haltingly, it was established that the whole world is subject to certain uniform laws and the monsters and marvels were banished—or almost banished—since tales of abominable snowmen and Loch Ness monsters are still with us. Men have come to understand that man's state is not unchanging—though the idea that all change is progress is less popular than it was. But whatever their ultimate beliefs, men have in varying degrees recognized that to survive they must come to terms with their environment, and the first necessity is to understand it. How the study of geography has developed in recent centuries, and the contribution it has made to the modern world, is the theme of this book.

CHAPTER TWO

Europe Discovers the World, 1400-1650

IN this chapter the geographical setting of the great age of discovery is examined and its effect on the outlook of geographers outlined.

The first and decisive step in the expansion of Europe overseas was the conquest of the Atlantic Ocean. That the nation to achieve this should be Portugal was the logical outcome of her geographical position and her history. Placed on the extreme margin of the old, classical Mediterranean world and facing the untraversed ocean, Portugal could adapt and develop the knowledge and experience of the past to meet the challenge of the unknown. Some centuries of navigating the coastal waters of western Europe and northern Africa had prepared Portuguese seamen to appreciate the problems which the Ocean presented, and to apply and develop the methods necessary to overcome them. From the seamen of the Mediterranean, particularly those of Genoa and Venice, they had learnt the organization and conduct of a mercantile marine, and from Jewish astronomers and Catalan mapmakers the rudiments of navigation. Largely excluded from a share in Mediterranean commerce at a time when her increasing and vigorous population was making heavy demands on her resources, Portugal turned southwards and westwards for opportunities of trade and commerce. At this moment of national destiny it was fortunate for her that in men of the calibre of Prince Henry, known as the Navigator, and King John II she found resolute and dedicated leaders.

The problems to be faced were new and complex. The conditions for navigation and commerce in the Mediterranean were relatively simple, compared with those in the western seas. The landlocked Mediterranean, tideless and with a climatic régime of regular and well-defined seasons, presented few obstacles to sailors who were the heirs of a great body

of sea lore garnered from the experiences of many centuries. What hazards there were, in the form of sudden storms or dangerous coasts, were known and could usually be anticipated. Similarly the Mediterranean coasts, though they might be for long periods in the hands of dangerous rivals, were described in sailing directions or laid down on the portolan charts drawn by Venetian, Genoese and Catalan cartographers. Problems of determining position at sea, which confronted the Portuguese, did not arise. Though the Mediterranean seamen by no means restricted themselves to coastal sailing, the latitudinal extent of the Mediterranean was not great, and voyages could be conducted from point to point on compass bearings; the ships were never so far from land as to make it necessary to fix their positions in latitude by astronomical observations. Having made a landfall on a bearing, they could determine their precise position from prominent landmarks, soundings or the nature of the sea bed, after reference to the sailing directions or charts.

By contrast, the pioneers of ocean navigation faced much greater difficulties. The western ocean which extended, according to the speculations of the cosmographers, through many degrees of latitude and longitude, was an unknown quantity, but certainly subjected to wide variations of weather and without known bounds. Those who first ventured out over its waters did so without benefit of sailing directions or traditional lore. As the Portuguese sailed southwards, they left behind them the familiar constellations in the heavens by which they could determine direction and the hours of the night, and particularly the pole-star from which by a simple operation they could determine their latitude. Along the unknown coasts they were threatened by shallows, hidden banks, rocks and contrary winds and currents, with no knowledge of convenient shelter to ride out storms or of very necessary watering places. It is little wonder that these pioneers dreaded the thought of being forced on to a lee shore, or of having to choose between these inshore dangers and the unrecorded perils of the open sea.

Many of these problems could be solved by time alone, by the hard-won accumulation of a myriad of isolated details, in fact by the patient study of a totally new environment.

Their astronomers and scientists provided them with declination tables of the sun and simple instruments, so that on their southward course they could determine latitude daily with considerable accuracy. Eventually, also, they came to understand and to allow for the variations of the magnetic compass due to the irregularities of the Earth's magnetic field. Applying the principles of chartmaking evolved in the Mediterranean, they charted many hundreds of miles of the coasts of Africa and Asia, until the fact that they were navigating on a spherical surface, and not on a plane, produced many puzzling complications which were not finally solved until Gerhard Mercator designed his famous projection in 1564. But in the long run, it was not upon the solution of such scientific problems that the successes of these explorers were founded; they rested upon sheer ability to handle a ship in all weathers, the dogged endurance of conditions which would be regarded today as unbearable, and on the will to succeed.

The Portuguese first directed their efforts to the mainland of North Africa, where they hoped to seize a share in the lucrative trans-Saharan trade and to control more effectively the western exit from the Mediterranean. But disastrous expeditions taught them that they were no match for the Moorish power on land, and they turned to seek other means by which their greater mobility at sea could be effectively employed—to establish direct contact with the gold-producing countries of the western Sudan and eventually to open up the sea road to that fabled treasure-house, the Orient. Progress along the coasts of north-west Africa was slow at first, largely owing to the inshore dangers and to the contrary winds and currents which made the homeward voyage difficult. However, as the result of a determined drive, the ill-omened Cape Non was rounded in 1433, and progress became more rapid. To the south also the immediate hinterland, where the Sahara desert approaches the sea, proved barren, and the scanty population hostile. On the high seas, discoveries (or re-discoveries) were made which provided valuable bases for future progress: Madeira was reached in 1418, and the Canaries were known from about 1420. More important was the discovery of the Azores group in 1427, as this provided

1. The world: progress of discovery and exploration.

an advanced base for further exploration westwards. But of most importance for the future, the Portuguese were acquiring from practical experience a knowledge of the wind systems and currents of the Atlantic which they turned to great profit.

In 1443, a little gold and some slaves were brought back from the Rio de Oro, the first fruits of a profitable trade; about the same time, the Senegal River and Cape Verde were reached in 1443, and Europeans for the first time saw for themselves the long-debated Tropics. The contrast between the arid Sahara and the prodigal life of the tropics was clearly described by Alvise da Cà da Mosto, a Venetian merchant skipper who explored this coast in 1455—"When we had passed in sight of Cape Blanco, we sailed on our course to the River Senegal, the first river of the Land of the Blacks, which debouches on this coast. This river separates the blacks from the brown people called Azanaghi, and also the dry and arid land (the Sahara) from the fertile country of the blacks. . . . It appears to me a very marvellous thing that beyond the river all men are very black, tall and big, their bodies well formed, and the whole country is green, full of trees and fertile; while on this side, the men are brownish, lean, ill-nourished and small of stature, the country sterile and arid."

What was astonishing to him and his contemporaries was the fact that to the south, which by all accounts should be uninhabitable on account of the great heat, they should find a land which, if not flowing with milk and honey, was endowed with a variety of natural resources and a vigorous population.

After a number of vicissitudes a permanent fortified settlement was established at El Mina (The Mine) on the Gold Coast and a base for the next forward step established. By this time the Portuguese had broken away from coastal navigation: on their return voyages they were boldly striking out into the Atlantic on a wide sweep which brought them to the Azores and so back to Lisbon. Later they reversed this course and were to round the Cape of Good Hope by sailing first on a south-west and then on a south-easterly course. In following this plan, Cabral discovered Brazil on his voyage to India in 1501. This knowledge of conditions in the North Atlantic also contributed in part to Columbus's choice of

routes on his first voyage: south to the Canaries and thence westwards, and on the homeward voyage a north-easterly course to the latitude of the Azores, taking advantage of the predominantly south-westerly winds. Some scholars have seen a mystery in his having hit upon the best coutes for his purpose at the first attempt, but here as in other matters he was undoubtedly drawing upon Portuguese experience.

While Portugal was expanding southwards, and somewhat later Spain to the westwards, other rising nations were opening up the North Atlantic. It is possible that by 1471, when Portugal was establishing a fort on the Gold Coast, British skippers in search of new fishing grounds (since political complications were excluding them from Icelandic waters) had probed the ocean westwards, and may have made a landfall in the Newfoundland area. Their task was rather easier than that which confronted the Portuguese. There was no question of long voyages into hitherto unpenetrated climatic zones, with all the navigational problems that this presented. Their early landfalls were 2,000 miles distant (the Portuguese faced open sea voyages of 4,000 miles) and were in a climatic zone similar, though harsher, than that of their native land. As the Elizabethan geographer, Richard Hakluyt, wrote, "we are not to cross the burnt zone [i.e. the Equator] nor to pass through frozen seas encumbered with ice and fogs."

In their search for a short road to the Indies, the British faced the unknown perils of the Arctic, a region at least as strange to them as the Tropics had proved to the Portuguese. Whether the English in the seventies of the fifteenth century discovered North America or not, John Cabot sailing from Bristol in 1497 made an indisputable landfall on Cape Race, anticipating Columbus in first sighting the American continent—though this was not appreciated at the time.

What then was the contribution of these pioneers to geography in these stirring years? They had circumnavigated Africa, opened the sea road to India, discovered America, and, transcending all these achievements, they had demonstrated the existence of lands altogether outside contemporary experience. They had shown beyond doubt that the Tropics could be traversed and that temperate lands existed in the southern hemisphere, and they had proved that with skill and

just as the Spaniards later discovered the equatorial upland regions of South America to be the source of unimagined wealth. The Spaniards also found themselves almost as much at home on the high dry plains of Mexico as they were in Castile, regions lying approximately in the same latitude. But the main result was ultimately to overthrow this theory of zones, and to initiate the collection of observed facts from which a sounder conception of the geography of the world was to emerge. The process was long and checkered, but its roots are discernible in these early records. The beginnings can be discerned in the writings of the Italian churchman, Peter Martyr. The earliest and one of the liveliest of the chroniclers of overseas discovery, he took great interest not merely in the voyages and adventures of the *conquistadores* but noted and analysed with considerable acumen their reports on the lands and peoples of the new world. He pointed out for example the differences between those parts of Africa and America which lay in the same latitude zone. The former suffered from the extreme heat of the sun and their inhabitants were black with short curly hair; in the same zone in America, the heat was less oppressive and the people were of lighter hue, with long lank hair. Other apparent anomalies also interested him: the existence, for example, within the torrid zone of snow-capped mountains. The conclusion he reached was clear—

"Wherefore it is apparent, the cause of this so great difference [i.e. between Africa and Asia] to be rather the *disposition of the Earth* than the constitution of the heavens. For we know that snow falleth in the mountains of the Equinoctial or burnt zone (the Equator) and the same to endure there continually. We know likewise that the inhabitants of the regions far distant from that line toward the north, are molested with great heat." By "disposition of the Earth" Peter Martyr understood the aspect of the region, the lie of the land, and the character of the soil and the rocks. These were the important factors, not absolute astronomical position on the globe, i.e. the "constitution of the heavens." The trees of great girth which astonished the first explorers of the South American coast, for example, were due to good soil and abundance of water as much as to the great heat; or again, he argued, the

highlands were more temperate than the coasts, and being by nature rocky were more likely to yield gold, but the fact of their "rockiness" implied that food supplies would be short and settlement consequently difficult. Each region with its own characteristics would have its own products. Peter Martyr was feeling his way towards a regional study set free from astronomical bonds.

A similar trend may be observed among English writers. Perhaps the best example is to be found in the writings of Richard Hakluyt the younger. He was an assiduous collector of narratives of exploration, indeed of any documents which would support his policy of overseas expansion. Many of these are published in his *Principall Navigations*, 1589 (enlarged edition 1599) and his theories of colonization are developed very clearly in the *Discourse of Western Planting*. The colonies were to serve three main purposes: to produce products which England was obtaining from abroad at great expense; to serve as bases which would protect the long-sought-after passage to Cathay; and to allow an offensive against the power of Spain to be mounted.

Studying contemporary maps and narratives, he suggested three points: the Straits of Magellan, from which the Spanish treasure-fleet sailing from the River Plate might be attacked; an island in the White Sea as a centre of trade with Cathay if the north-east passage proved navigable (this would also be an outlet for British woollen goods), and a suitable point in north-east America to protect the north-west passage, where a colony might be established. Experience was to show that the first suggestion was founded on misconceptions of the character of the extreme south of America and neglected the geographical factor of distance; it was never attempted. The second was abandoned when better information on the area came to hand and it was apparent that the north-east passage afforded no practical route to eastern Asia. The third after many vicissitudes and the failure of attempts 1585-7 to establish colonists in Virginia, was the only one to be successfully carried out with the founding of New England in 1620. By that time, however, it had ceased to have much relevance to the north-west passage.

In the early experiences of the English overseas, we can also

see the theory of zones breaking down. In accordance with it, conditions paralleling those in Britain should be found in Newfoundland and Labrador; in practice it proved necessary to seek them further south in what was to become New England. The important point here is that the reasons for this were partially discerned; the inhospitable and barren features of Labrador were seen to be due, not primarily to its northerly latitude, but to local climatological conditions—in this case the proximity of the cold Labrador current, with its drifting pack-ice, bergs, cold winds and fog.

In this empirical fashion the English began to form a truer conception of geographical principles. Much of their reasoning was remarkably acute. An excellent example of this is provided by the description of Russia written by Giles Fletcher in 1591. He describes for instance the benefits of the heavy winter snow cover: how it protected the vegetation from the severe cold in the early months of the years and how, when it thawed, it promoted an early and lush growth. To this he linked the annual migration of the Tatars, explaining how they followed the retreating winter northwards, with their flocks enjoying the first growth, and subsequently swung south again to benefit from the second growth. This is a fundamentally sound diagnosis of what is now known as "transhumance." To take one more example from a quite different sphere, Hakluyt included among his documents a detailed account of the monsoonal régime of the Indian Ocean, and related it to the seasonal changes in Indian coastal navigation.

It was long before such reasoning was integrated into a systematic and comprehensive description of the world. Indeed such arguments were ignored for many years by the learned writers of textbooks, for reasons which will be examined later. Thus the general public, in so far as it was at all interested, received a distorted picture of the new world. The first account of America in English did not appear until nearly thirty years after Columbus's discovery, and then in a text translated by a Dutch writer with an imperfect command of the language. The following extract is an example of its quality:

"There we saw many wonders of beasts and fowl that we have never seen before. The people of this land have no king

nor lord nor god. But all things in common. This people goeth all naked. But the men and women have their head, neck, arms, knees and feet all with feathers bounden for their beautiness and fairness. These folk live like beasts without any reasonableness and the women be also in common. And they eat also one another. And that land is right full of folk for they live commonly three hundred years and more, as with sickness they die not. . . ." It would be difficult to compose a more misleading summary, and one in general more at variance with the explorers' reports.

CHAPTER THREE

Seventeenth-Century Geographers

THE seventeenth century was, for the European powers, a period of consolidation overseas rather than of further expansion. In Europe itself, the age was marked by internal strife, religious and political, as the Thirty Years War and the Civil War in Britain demonstrate. This was followed by the opening of the long struggle for supremacy between France and Britain waged over the oceans and in four continents. During the first half of the century the lead in expansion was held by the Dutch. Firmly entrenched in a naturally protected base, displaying a methodical aptitude for maritime affairs, developing the sciences of navigation and cosmology beyond the stage reached by their former Spanish masters, and commanding through their hold on the lower Rhine valley one of the great European trade routes, the Dutch built up a formidable naval and commercial empire. In the East and West Indies they broke the monopolies of Spain and Portugal, secured their sea route to the east by establishing a station at the Cape of Good Hope and planted a rival colony on the North American seaboard. In the Far East, alone of all European countries, they established and maintained trading posts in Japan. In pursuit of their trade policies they despatched embassies to the courts of the Shah of Persia, the Emperor of China and other lesser oriental potentates Much of Europe's knowledge of a great part of Asia and of contemporary events therein was drawn from the voluminous, detailed and matter-of-fact reports of these missions, lavishly augmented by illustrations and maps from plates engraved on copper in the style perfected by the great publishing houses of Amsterdam.

Following in the wake of the English in the Arctic in search of the north-east passage, Dutch skippers were the first to winter in the far north. Their greatest effort, however, was made in the south and particularly in the Pacific Ocean. After

the grim experience of Magellan's crews in that ocean, the Spaniards, having discovered a practical sailing route between Mexico and the Philippines, had contented themselves with probing rather half-heartedly to the south-west, where they hoped to discover the hypothetical southern continent which from the time of the Greek philosophers was supposed to be necessary to balance the northern land masses. The history of this continent is outlined later in the chapter on the Antarctic.

Their English rivals did not follow them resolutely into these waters for a century, but made their main effort in North America. Their great achievement was to plant permanent colonies in Virginia and New England. Fortunately perhaps for their future they confined their energies to the area east of the Appalachians; it was not until the colonists had broken away from Britain in the following century that frontiersmen crossed the Blue Mountains into Kentucky and the Anglo-Saxon opening-up of the continent began in earnest.

Further north, another English advance contributed to this movement. The English never entirely abandoned the search for a northern passage to the Pacific, but had so far failed to push westwards beyond Hudson Bay. It was natural therefore that the courtiers and merchants of the City of London, headed by Prince Rupert, should listen with attention to the proposals of two French renegades that they should establish trading factories on the shores of Hudson Bay and divert the fur trade, particularly the valued beaver pelts, from French hands into their own. The upshot was the foundation of the Hudson's Bay Company with factories in "the bottom of the Bay" (i.e. the southern shores of James Bay) and at York Factory on the western coast. The English were primarily sailors and merchants who did not take kindly to the new and harsh environment. They were content at first to wait for the Indian trappers to bring the pelts to the forts, rather than to push up the rivers to the source of the supplies. Critics, angered at the Company's monopoly, jeered at this "long sleep by the frozen sea."

The French, on the other hand, pursued a forward policy. Missionary priests, trappers and *couriers des bois* were captivated by this great new country; with enthusiasm and determination they adopted Indian techniques of travel and of

"living off the country." Pushing up the innumerable rivers, portaging round the rapids, learning to live rough, to hunt and to cure meat, they penetrated into the interior from their bases at Quebec and Montreal. Lake Huron was sighted in 1615, and the falls of Niagara in 1679. A century later, La Vérendrye reached the western prairies and sighted the Rocky Mountains far in the distance. But their greatest achievement during this period was the descent of the great River Mississippi to its junction with the Arkansas river by Father Jacques Marquette in 1673 .This journey made it plain that the Mississippi entered the Gulf of Mexico, thus destroying the widely held idea that "the great river of the west" provided a waterway to the Pacific Ocean which would in some degree serve as a substitute for the north-west passage. These discoveries revealed the great size of the continent and its potentialities. In reply to the English move from Hudson Bay against their supplies of fur, the French thus threatened to confine the English influence to the Atlantic seaboards.

In this period a rather similar movement was taking place in Asia, where the Russians were carrying out their drive eastwards across Siberia, reaching the Pacific coast in 1647.

The geographical literature of this century consisted mainly of the records of these achievements, and in general these were rarely of a kind to fire the imagination of the general public. Tasman's narrative, for example, was largely the record of a professional seaman, and the abridged published version was scarcely more attractive. The accounts of the French penetration of Canada achieved greater popularity with their descriptions of the mighty Mississippi, the Great Lakes and the wonders of the Niagara falls. The English travel books which created a sensation were the work of a gifted but somewhat bizarre individual, William Dampier. After some years in the Pacific, for part of the time as one of a buccaneering crew, when he acquired an extensive knowledge of the winds and currents of that ocean, Dampier returned to England and persuaded the Admiralty to put him in charge of a scientific expedition to the south-western Pacific. His defects as a commander outweighed his keenness as an observer, and he failed to achieve all that was expected of him. He examined two portions of the west and north-west coasts of

Australia, and his account is the first by an Englishman of any part of that continent. He was no enthusiast for the "noble savage," rating the inhabitants lower than the *Hottentots*. The real claim of this expedition to notability was the fact that it was the first to be despatched from Britain for a purely *scientific purpose*.

In this it expressed the new spirit of inquiry which had been marked by the foundation of the Royal Society in 1660, and which in the history of science is associated with the names of Descartes, Galileo and Isaac Newton. It was some time, however, before this spirit greatly affected the study of geography. Newton himself was interested in the subject as it was then understood, being responsible for a revised edition (Cambridge, 1672) of the standard work on geography, the *Geographia Universalis* of Bernard Varenius, first published at Amsterdam in 1650. Varenius, a German long resident in the Netherlands, made a valiant attempt to systematize the study of geography, drawing freely upon past and contemporary writers. He made two main divisions, "general" and "special." Under the first he dealt with the earth as an independent body, and in relation to other planets. A third section, rather obscurely called comparative, is concerned with the determination of position and the study of cartography—apparently viewed as the comparative consideration of places and areas on the earth's surface. These sections, therefore, are largely mathematical and astronomical, and it was these aspects which appealed to Newton. Varenius's second division, "special" geography, was to deal with the Earth's surface features, mainly the mountains, forests and deserts, and also the oceans and the waters of the land. He provided a lengthy synopsis of what this section was to cover, but it was never written. Indeed, he seemed to doubt whether these topics could properly be included in geography: "We are obliged to admit them for Custom sake, and the Information of the Reader."

He attempted to classify the various surface features on a descriptive basis, drawing largely on his extensive reading of travel narratives. These lists suggest to us the "capes and bays" type of geography schoolbooks still in use at the end of the last century. Mountains, for example, are classified

according to their extent and relative height, whether they produced metals or not, and so forth. He also distinguished "burning and smoking mountains" those continually covered with snow, and those without snow in summer.

No progress along these lines was possible until such phenomena had been classified on a genetic basis, and the course of their evolution established. Nevertheless, running through this section are signs that Varenius was searching for underlying principles. Those portions which deal with physical geography and hydrology are the most enlightening in the book. He was aware that the surface of the Earth was not unchanging, as the following quotation clearly shows:

"Nevertheless History acquaints us, that not a few Mountains have been undermined by interior ruins, and sunk down into subterranean chasms and receptacles, or wasted by some other means; so that since we can perceive a natural decay and corruption of them, we may judge that they do not proceed from a supernatural origin. Moreover, that several mountains were raised successively, and at several times, is apparent from the quantities of sea-shells that are found in some of them, as in those of Gelderland."

He had also more than an inkling of what the "other means" which wasted the surface were, though his explanation is based on faulty premises. In fact we find here the conception of the hydrological cycle in embryo. Apart from the sinking into subterranean chasms, he argued that running water was the main erosive force. As he believed that water derived from rain and melting snow did not penetrate more than ten feet below the surface, he rejected it as the operative agent, and sought the latter in the waters of the oceans which penetrate "through subterraneous fissures" into the interior of the earth. They are then forced to the surface by two agents: the earth's internal heat and the heat of the sun. During this process the salt sea-water becomes purified. The rivers return the water to the sea, and the whole process is then repeated.

The erosive powers he attributed to rivers appear to be relatively slight, being mainly accomplished by the "violent beating" of the streams against their banks. No doubt as a result of what he had seen in Holland, he recognized the role

of rivers in transporting suspended materials, and he wrote with perception on the formation of river islands and sandbanks, and changes in the channels of rivers. There is a curious passage in which he concluded that river valleys which are not of the same age as the earth must have been made by the industry of man—probably another reflection of his observations in Holland. He also appreciated the seasonal character of river régimes and made some sensible remarks on the Nile floods. In considering the formation of coastlines he pointed out that some bays are formed by the shattering of the surface through subterranean disturbances, as is shown by the similarities of the strata on both sides of the bays. Certain other changes are due to the advance or retreat of the sea. Ocean currents are attributed to the winds, which are themselves due ultimately to the power of the sun (here again he reached a correct conclusion from faulty reasoning). He also points out the seasonal character of winds and storms.

As has been stated, Varenius never wrote his "special" geography, corresponding to what we should now call human geography. It happens that an English geographer had written a work very similar to Varenius' which included this aspect. Nathaniel Carpenter, Fellow of Exeter College, Oxford, published the first edition of his *Geography Delineated Forth in two Books* some years before the *Geographia Universalis*, and since they both used the same methods and much the same sources, it is not surprising that their texts, where they overlap, embody similar conclusions. Carpenter was very strong on the supremacy of natural laws. To accept, for instance, objections to coastal erosion on the grounds that "God set a bound upon the seas which they should not pass" would in his view be to "impose a perpetual violence upon nature." Those who did so received short shrift at his hands. "The authority of those Divines," he proclaimed, "was not so great in these cosmographical conceits as to oversway those of the same profession who could more easily judge of these matters."

Since we have dealt with Varenius' ideas on physical geography, it is unnecessary to recapitulate those of Carpenter, beyond noting that there are some differences in detail. Carpenter did not accept the argument that the erosive waters were derived from the oceans, but thought that they came

from deep underground supplies, and he developed at some length the theme that while the mountains were being worn down, the valleys were being filled up by the debris.

In human geography Carpenter's themes were drawn largely from the French political theorist, Jean Bodin, who was to some extent still in thrall to astrological ideas on the zones, but attached importance to what we now understand by climate rather than the influence of heavenly bodies. He divided the hemispheres into three main zones, torrid, temperate and cold, ascribing certain characteristics to the inhabitants of each. He perceived that within each zone there were factors which led to variations among their inhabitants, and conceded that in certain circumstances men were not dominated by geography.

Carpenter developed Bodin's theme rather more dogmatically, discoursing of the "naturall disposition" of men, that is, their complexion, manners, actions, languages, laws, religion and government, in so far as they are related to their position on the earth's surface and "the temper of the air and soil." Here he developed at length that favourite proposition, the virtues of the men of the north as against those of the south. The former, living in an invigorating climate whose cold air induces activity, are brought up, as we should say, the hard way, on a frugal, wholesome diet. In consequence they are fertile, tall and strong. How feeble, in contrast, are the southerners, languid in the heat! This line of reasoning is also applied to extol the supriority of the inhabitants of mountain and highland over those of the plain. Carpenter was indeed at great pains to defend mountain-dwellers against accusations of boorishness and ignorance, writing with much eloquence of the great men nurtured in his native county of Devon.

Carpenter arrived at these conclusions largely by studying descriptions of the peoples of the southern continents. He regarded Europeans as members of nations who had learnt to exploit the benefits of the soil and who were skilled in the arts of civilization. Their voyages and conquests brought them into contact with peoples who had failed to emulate the European achievement. Upon these benighted folk, ignorant, he pointed out, of schools and universities, the newcomers had conferred riches "whereof the poor wretches never knew the

want." In his search for the most favoured region of the world, Carpenter eliminated the entire southern hemisphere. By similar reasoning he proceeded to strike out the western (American) half of the northern hemisphere. The final step was to exclude the eastern portion of the remainder, i.e. most of Asia. The result—no doubt the desired result—was to show that the most advanced region was Europe. It is easy to smile at this rather naïve procedure, but it is ironical to reflect that a notable American geographer, Ellsworth Huntingdon, was much later to conclude that Western Europe was climatically the most favoured region for human activities.

Despite his sometimes cavalier treatment of many nations, Carpenter concluded with an appeal for peace and tolerance: "But those who so arrogantly boast themselves to be Sons of the Earth, not beholding to any other country for their offspring [i.e. those who believe in the independent origin of their country] strive to break in sunder the bonds of society betwixt nations, which God's word and the law of nations bidds us to observe."

We can see now why Varenius, Carpenter, and their contemporaries went astray; it was simply the lack of sufficient factual knowledge. It is true that they recognized the necessity of building upon facts, but what were their facts? They were the uncontrolled observations of men of varied capabilities in far-off regions of the world, the speculations of long-dead philosophers, and selected texts from the Bible. These they attempted to reconcile with the all-too-small body of more rigorous contemporary observations. It has been pointed out that Varenius was frequently better informed on distant parts than he was on areas of his own Europe. The clamant need was for facts, facts, and still more facts, systematically collected; and the next period in the history of geography might well be named "the age of fact-finding." Without them, generalization and theorizing were dangerous pursuits. But at least geographers were aware of the stage that had been reached. The anonymous editor of Thomas James's Arctic narrative, 1635, could write: "You shall see in this little booke, how Charlton Iland, which is no more northerly than your Cambridge, is yet so unsufferably cold, that it is not habitable. Tis not to be doubted, but that the careful reading

of our Books of Voyages would more elucidate the History of Nature, and more conduce to the improvement of Philosophy, than any thing that hath been lately thought upon."

The work of these men, therefore, should not be dismissed too lightly. To an appreciable degree, they had begun to cast off the bonds of tradition and antique authority, and for better or for worse, they influenced European thought and action at a critical point in the history of the world.

CHAPTER FOUR

Explorers and Philosophers, 1650-1800

We have seen how the progress of geographical thought was being hampered by the lack of reliable facts. The period we have now reached, which extends approximately from 1650 to 1800 and which merits the title of "the second great age of discovery," provided facts in plenty. At its close the configuration of the continents had for the most part been revealed and described, not only by the navigators but often by men of science who accompanied them. But of equal, if not greater importance, this new world was viewed by Europeans from a totally different standpoint, thanks to the revolution in philosophy inaugurated by a group of French thinkers in mid-eighteenth century. The history of exploration, interesting and exciting as it is, cannot be followed in detail here, but it is necessary to indicate its progress and the impulses behind it in order to understand the kind of facts with which they provided the philosophers.

So far little has been said about the continent of Asia, where much of our culture originated. Europe could not, therefore, discover Asia; it is more realistic to speak of a re-discovery or recovery, and not only one, but a series of re-discoveries. From some aspects, the main lines of Asian exploration by European peoples are similar to those in Africa. It was first an exploration by sea, followed by attempts to establish relations with the societies and their rulers who controlled the coastal trade. Unlike Africa, where the earlier contacts were bedevilled by the traffic in slaves, the first objectives were more legitimate. Moreover, the East has always inspired in the West a sense of awe, of reverence almost, as the home of civilization and of wisdom. From the first there was thus a degree of intellectual curiosity mixed with commercial ambitions, an influence which became increasingly powerful, and was later the inspiration of many great journeys by archaeologists and students

of religion, linguistics and art. Asia was there to be described and interpreted; Africa was largely the creation of its explorers.

The coastline was revealed fairly rapidly. The Portuguese were in the Moluccas by 1520, and in Macao a few years later. Saint Francis Xavier was attempting to convert Japan in the mid-century, after which progress languished for a time. A century later, the Russians were established on the north Pacific shores, and in 1648 the Russian Dezhnev had sailed from the mouth of the Kolyma river beyond the north-eastern point of the continent, thus revealing its separation from North America. The significance of this discovery was not appreciated until the results of Vitus Bering's voyages in the strait and on the coast of Alaska were digested by the savants of the Tsar's court in the early eighteenth century. Meanwhile the slow penetration of the interior by Europeans had begun. Strangely enough the first great step forward was made from the furthest extremity. While European knowledge of India was largely confined to the neighbourhood of the trading factories on the coast, Jesuit missionaries, among whom was Father Matteo Ricci, had gained entry into the Chinese Empire. Under imperial auspices they rapidly traversed China proper, describing and surveying the country with enthusiasm and enormous industry. They were soon across the Amur river into Manchuria, and later into Tibet and central Asia.

Tibet played a similar part in the European exploration of Asia to that performed by the Niger River and Timbuktu in Africa, for it was the hub around which the explorers' routes revolved, its capital, Lhasa, remaining a tantalizing but, for political reasons, forbidden goal. The first journeys across central Asia were undertaken to link the missionary enterprises in India and China. In 1602 the Portuguese de Goes journeyed through the Himalaya to Kabul, thence over the Hindu Kush to Yarkand Here he joined one of the main routes through central Asia, lying between the Takla Makan desert and the foothills of the Tien Shan. The route south of the desert is of even greater importance, being in fact the principal east-west route, followed by ninth-century Buddhist monks and twentieth-century archaeologists. From Turfan de Goes reached China at Suchow. Some years later, Benedetto Desideri, after a hazardous journey from Delhi,

succeeded in reaching Lhasa where he passed five years studying Tibetan language and culture.

The discovery of the Pacific, the last great ocean to be revealed to Europeans, came towards the end of this period. In one sense it was the opening-up of an alternative or "back-door" route to America and Asia. But since this ocean occupies very nearly one-half the surface of the globe, there were also possibilities of bringing to light considerable new land-masses within its limits. The Asian shores of the Pacific were largely known by 1700. The charting of the American shores was completed in the following century through the voyage of Vitus Bering to Alaska and those of Cook and Vancouver, who completed the work of their Spanish predecessors on the north-west coasts.

The last two navigators also contributed largely to the exploration of the southern half of the ocean. From the Renaissance onwards, there had been much speculation on the existence of a great southern continent around the South Pole which was thought to extend, in the Pacific at least, far into temperate latitudes. Into this framework some had fitted New Guinea, Tasman's New Zealand and Tierra del Fuego. The circumnavigation by Magellan had thrown little light on this problem, since he had traversed the Pacific in a northerly and north-westerly course, and Spanish voyagers, such as Mendaña and Quiros, by misinterpreting their discoveries of the Solomon and other island groups, had complicated rather than resolved the problem.

The Dutch, before their imperial energies were overstretched, had plans to expand into the Pacific. One controlling factor here was the belt of steady westerly winds between 40° and 60° south, the "roaring forties," which discouraged attempts to sail westwards from the Straits of Magellan. The Dutch had hoped to approach this area from the East Indies in the north-west, but the first successful attempt to solve the problem was made by Captain James Cook from the north.

Cook finally removed the inflated southern continent from the world map, much to the chagrin of his contemporary, Alexander Dalrymple. His first voyage, southwards from Tahiti and westwards to New Zealand and eastern Australia,

was in this respect merely preparatory; it was his second voyage in high southerly latitudes, when for the first time he penetrated south of the Antarctic circle that reduced it to something like the reality of Antarctica. His third voyage was a major contribution to the geography of the North Pacific.

Cook was not without rivals, though none surpassed his achievements. Thwarted by Britain in North America and in the Indian Ocean, France eagerly accepted the challenge presented by the Pacific and made valiant attempts to discover and found a new *imperium* there. Bougainville in fact came near to anticipating Cook in the exploration of eastern Australia. Sailing via Tahiti and Samoa, he sighted the Great Barrier Reef off northern Queensland but, with dwindling supplies towards the end of a long voyage, he was in no condition to venture further into these dangerous waters; accordingly he set his homeward course by the north coast of New Guinea. The second great French effort was made by La Pérouse, who filled in much detail of the Pacific, following in Cook's wake. In 1785 he put into Port Jackson, in eastern Australia, only to find that a British settlement had just been established there. Not long afterwards his entire expedition was lost in the Santa Cruz group.

All this widespread activity had a profound influence on European thought. The "discovery" of China in the seventeenth and eighteenth centuries, revealing a long-established civilization with its own political, social, artistic and religious systems, profoundly affected the political thinkers, particularly in France, who were preparing the way for the great revolution. The reports of China and its people stimulated and reinforced their arguments that society was not necessarily permanently cast in the mould of the *ancien régime*. In the peoples of the Pacific Islands, idealized by explorers, they found, as they had already done among the North American Indians, materials for their picture of the "noble savage" whose supposedly simple life and childlike innocence were held to condemn the hidebound conventions and iniquities of their own society. It should be remarked however that men like Cook, tolerant though their outlook was, failed to discern these "noble savages" in the islanders they knew.

Discovery was not the sole aim of Cook's voyages; his first had as one object the observation of the transit of Venus at Tahiti, and for this purpose he was accompanied by an astronomer, Charles Green. But the possibilities of the voyage had also fired the imagination of Joseph Banks, a wealthy landowner with a passion for botany. With the permission of the Admiralty and at his own expense, he joined the *Endeavour* with what might be called a scientific staff, comprising Dr Solander, "the ablest botanist in England," an assistant naturalist, and two draughtsmen or artists, all well equipped for their tasks. As a contemporary noted, they took with them "all kinds of nets, trawls, drags, all sorts of machines for catching and preserving insects; and hooks for coral fishing, they have even a curious contrivance of a telescope, by which, put into the water, you can see the bottom at a great depth, when it is clear."

Banks's interests were not confined to botany, and his journal contains perceptive descriptions of the islands visited, accounts of the native peoples, their social and religious systems, languages, and material culture. Much of this material was incorporated with Cook's journal in the official account of the voyage compiled later by Dr Hawkesworth. Perhaps Banks's greatest contribution to the success of the expedition was the flair he showed for understanding the point of view of the natives and for acting as a tactful intermediary between them and their unexpected visitors. It is not inappropriate to describe Banks as the geographer of the party. Unfortunately, no systematic technique of publishing scientific results had yet been devised. Hawkesworth's account was accompanied by a volume of plates engraved after the drawings of Sydney Parkinson, the artist. The botanical results were never published (rather strangely Banks never published anything during his lifetime) but the great collection of specimens and his extensive library were always available to serious students.

For certain reasons Banks did not accompany Cook on his second voyage. Substitutes were found in J. R. Forster and his son George, an unfortunate choice as it turned out, for the father was quarrelsome and vindictive, with a host of grievances. The younger Forster, however, forms an impor-

tant link in our story, through his influence on Alexander von Humboldt, the man who was to transform the study of geography. Humboldt is important because he was both a traveller, in the way Banks and the other civilian voyagers in the Pacific were, and the first modern scholar to attempt, proceeding from scientific principles, to view the study of geography as a whole, and his work became the starting-point for numerous new lines of research. With an inborn love of nature, he was inspired by the teaching of George Forster and his reminiscences of the Pacific world to appreciate the value of extensive travel and the importance of evocative descriptions of the natural world written in an attractive prose style. To these he added a passion for scientific inquiry stimulated by the contemporary evolution of scientific thought. It was no mere chance that much of his working life was spent in Paris.

Throughout the first half of the eighteenth century, the revolution in philosophy associated with the careers of Montesquieu, Voltaire, and Rousseau was effecting a change in outlook which slowly but decisively affected the development of the human sciences through such works as the great *Encyclopaedia*. In their attack on the abuses of the *ancien régime* the men of the Enlightenment rejected the conception of a static authoritarian system of society firmly rooted in the past. Each society was to be studied as the product of its own environment and history, in a world operating under the rule of natural laws. The duty of statesmen was to understand these laws so that they might remould society in the interests of the sovereign people. It was rational for these philosophers in so doing to be led to consider the role of the geographical environment.

Jean-Jacques Rousseau, for instance, though not generally regarded as a geographer, has some interesting observations under this head. The environment, and not only through its beneficial aspects, exercises a stimulus on primitive man: "The differences of soils, climates and seasons must have introduced some differences into their manner of living. Barren years, long and sharp winters, scorching summers which parched the fruits of the earth, must have demanded a new industry." These differences, he thought, were still at

work: "The nearer you get to the Equator, the less people live on. Meat they hardly touch; rice, maize, millet, and cassava are their ordinary food. There are in India millions of men whose subsistence does not cost a penny a day. Even in Europe we find differences of appetite between Northern and Southern peoples. A Spaniard will live for a week on a German's dinner."

It is interesting to see the contrast between north and south still persisting. Rousseau accepts it without carrying his inquiries much further, into, for instance, the reasons for the relative poverty of India. That he had some conception of maximum output and optimum population is clear from his consideration of the best size for a state. In reading the following quotation we must remember that to him the state was anathema, but since it must exist the smaller and the less dependent on outside assistance the better. "The men make the state and the state sustains the men. No fixed relation can be stated between the extent of territory and the population that is adequate, the one to the other, both because of the differences in the quality of land, in its fertility, in the nature of its products, and in the influence of climate, and because of the different tempers of those who inhabit it; for some in a fertile country consume little, and those on an ungrateful soil much. There are cases in which the particular local circumstances demand or allow the acquisition of a greater territory than seems necessary. Thus expansion will be great in a mountainous country where the natural products, i.e. woods and pastures, need less labour, where we know from experience that women are more fertile than in the plains, and where a great expanse of slope affords only a small level tract that can be counted on for vegetation. On the other hand, contraction is possible on the coast, even in lands of rocks and nearly barren sands, because the fishing makes up to a great extent for the lack of land-produce, because the inhabitants have to congregate together to repel pirates, and further, because it is easy to unburden the country of its superfluous inhabitants by means of colonies." Here he is contrasting the mountain republics of Switzerland with the city states of the Mediterranean. It is curious at first sight that he does not mention external trade as capable of making

up deficiences in "land-products," nor does he examine the possibilities of industrial development—he was writing before the industrial revolution. This quotation shows that when endeavouring to think "geographically" he was liable to select isolated instances to support his argument. Nevertheless he recognized that the relations between geography and history are not as simple as had been supposed, that physical factors do not necessarily override the human, and that the time factor must not be neglected.

There was however an interval before this new intellectual activity began to exert its full influence on geography, though the ground was being prepared for an advance. These political theories and the growth of commerce were stimulating the collection and study of statistics, thus fostering the growth of economic geography. Quantitative methods were also being increasingly applied to the natural sciences, for instance to meteorology.

The practical everyday affairs of men were providing a mass of as yet unco-ordinated knowledge. The extension of mining was forming the basis of geological studies, navigators were accumulating observations on terrestrial magnetism and ocean currents, as were farmers and gardeners on plants and soils. Without a cohesive principle, however, geography was languishing; offering little to fire the imagination or to attract the new spirit of inquiry it remained dull and lacked any grace of literary style. As an example we may glance briefly at a small book which was popular in Germany between 1785 and 1795, Johann Ernst Fabri's *Kurzer Abriss der Geographie* (Short Outline of Geography). The general approach is reasonable: geography is knowledge of the Earth and of man as they are today, and is divided into mathematical, physical, and political sections. Climate receives a surprisingly mature treatment, being regarded as determined by position, soil and weather. The chief characteristics of all men are similar, but what a difference there is in their strength and stature, their culture, and in their colour. There is an interesting estimate of the total world population—put at 900 million. The general tenor is pietistic: "Only a few people on our planet are so wild as not to believe in a future life, or at least to conjecture it." After a brief introduction, the text becomes an arid list

of countries, political divisions, cities, reigning houses, etc. Strong emphasis is placed on the usefulness of maps, and in fact most of the detailed information could have been given more conveniently in this way.

Another similar little book, J. C. Gatterer's *Kurzer Begriffe der Geographie*, has a paragraph of significance in view of what was to come: "It would be a very fortunate circumstance if a weather observer could survey in a single glance the state and the changes of the atmosphere and thus the whole course of the weather. But such a view is not given to the limited eye and spirit of man. He must, as with every great unit including the weather, seek to examine it step by step and partially." Yet the author accepted that facts can be put together to prove laws more reliable than popular sayings. Taking a broad view, he thought the inhabitants of the world are fortunately placed and are on the march to eternal life. Creatures are born and die, but numbers are pretty constant. Growth and decline in numbers are due to the characteristics of the land and to the established form of government. The latter works mainly through the extent it engages in or avoids war: at any rate wars should be short, otherwise they are too costly.

It is against such a background and the stimulus of the new philosophy that the contribution of Humboldt must be seen. In him there come together the various strands which we have glanced at. His celebrated journey in South America, with Aimé Bonpland (1799-1803) proved him to be an accurate and painstaking surveyor, an industrious botanical collector, a student of social and political conditions, an untiring inquirer into the myriad of natural phenomena which presented themselves to his keen eye; but above all he was pondering upon the natural world and searching out its underlying unity. During these fruitful years he learnt and applied the injunctions which he instilled into succeeding generations of geographers—observe, check, collate, verify, and deduce. Among his disciples were to be men of the calibre of Robert Schomburgk, Heinrich Barth, and H. W. Bates.

Three of his works principally concern us here: his great series of volumes based on his travels in South America; a series of essays on scenes in nature (*Ansichten der Natur*,

1826), and his general treatise, *Kosmos; a sketch of a physical description of the Universe*, five volumes, 1845-62. To this influence must be added the direct stimulus he gave to exploration and research. An outstanding example is Sir James Clarke Ross's Antarctic expedition of 1839-43. Undertaken by the British government at Humboldt's request to collect data on the Earth's magnetism, it resulted in the discovery of the Ross Sea and of Mounts Erebus and Terror.

Secondly he took immense pains to acquaint himself with the achievements of his fellow scientists and to embody them in his own system. He owed much in this respect to the geologists, Leopold von Buch (1774-1853) and Élie de Beaumont (1798-1874) for their work on the nature of the Earth's crust and its movements, the relative age of mountain chains, the role of earthquakes and volcanoes and many other aspects of Earth history.

Similarly, in his development of climatology he applied the results obtained by the pioneers of scientific meteorology. This is now of course only common form among scientists, but in the circumstances of the day it was in itself no mean feat. It can be said with profound significance of Humboldt that for him science knows no national boundaries.

Thirdly, there is the breadth and humanity of his outlook. His works display a remarkable feeling for the perspectives of history and the growth of man's appreciation of nature. It is not that he is able to quote to effect Aristotle, the early fathers of the Church, medieval travellers, Renaissance painters or English poets that is so striking, but his ability to comprehend them all in the great chain of human achievement. Humboldt used his authorities with discretion—they are not employed merely to decorate or to impress—and his arguments are presented without dogmatism or an assertion of infallibility. He clearly was liable to error, and in the light of later developments some of his views must necessarily appear naïve or antiquated. But his work and position as a geographer stand unassailable, because he perceived clearly the limits of the field in which he was working, he was guided by clear-cut principles, he realized that finality was not to be achieved, and was animated by a sense of the grandeur (that now outmoded quality) of the task in which he was engaged.

He did not envisage himself as delivering the laws; his task was to seek them out. What, then, is his contribution to geography?

It lies as much in his general approach as in his individual contributions to specific problems. The *Kosmos* is a harmoniously ordered whole, terrestrial and celestial, in and through which nature operates as a "unity in diversity." The aim of research was to attain "a knowledge of the chain of connection by which all natural resources and forces are linked together and made mutually dependent upon each other." This knowledge is "the fruit of observation and intellect, combined with the spirit of the age in which are reflected all the varied phases of thought." It should be noted that Humboldt did not exclude man from this concept though, as will be seen, he treated this aspect warily.

This study is not "a mere encyclopaedic aggregation of the most important and general results gathered from special branches." In this declaration lies Humboldt's fundamental point of departure from the eighteenth-century "systems of nature." In his scheme, that which concerns general physics, descriptive natural history and geology constitutes "physical geography." He emphasizes the instability of the Earth's crust in geological and historical time, evidence for which can be read in the record of the rocks and in contemporary processes (volcanoes, earthquakes, etc). The present configuration of the Earth's surface is important, particularly in relation to the two "envelopes" which surround it; the atmosphere and, in part, the sea. Upon their interrelations depend the "differences of climate on the Earth's surface, according to the relative extension of the aqueous and solid parts, the form and extent of the land, and the direction and elevation of mountain chains." The area and distribution of the water surface influences the distribution over the land of temperature, pressure, wind direction, and humidity. The sum of all factors is expressed in the distribution of vegetation.

This bald and compressed summary of Humboldt's view of physical geography is sufficient to show at least that the modern concept of that study stems unchallengeably from his work, however much later research has contributed quantatively, modified some of his larger generalizations, or revealed finer

to the science of the Cosmos." Such exalted aims are not for him; the progress of geography would have been more rapid and more soundly based if some of his contemporaries and successors had followed his lead in resisting any temptation to journey further in this direction. One can almost hear him sigh with relief as he concludes one section of his *Kosmos* with the declaration: "A physical delineation of nature terminates at the point where the sphere of intellect begins, and a new world of mind is opened to our views."

Generally associated with his contemporary and fellow-country man is the second prominent German geographer, Karl Ritter. Though they had much in common—a wide-ranging outlook, a search for underlying principles, almost terrifying erudition and an enthusiasm which stimulated and inspired their students—it is the differences which are the more striking and eventually of greater importance. Though an ardent advocate of direct observation in the field Ritter's experiences, compared with those of Humboldt, were limited and less dramatic, for his journeys were confined to western Europe. Ritter was essentially a historian—he held a chair of history before becoming Professor of geography at Berlin—while his compatriot was first and foremost a natural scientist. While Ritter seeks in geography a tool which will help to explain the course of human history, Humboldt for the most part strives to demonstrate the unity in diversity of the physical world and eschews any dabbling in speculative philosophy. We have seen how cautious is Humboldt's approach to the relations between man and geography. Ritter on the other hand is an ardent enthusiast for the moral and political ideas of his day. He is considerably influenced by the idealistic theories of the state propounded by the German philosopher Hegel. To Hegel the state was more than an association of men for their mutual benefit: it was an overriding moral unit with a life and purpose of its own, transcending those of the individual citizens. The history of these units is closely related to the geographical environment in which they develop, flourish and decline. The title of Ritter's encyclopaedic and unfinished work illuminates this view: "Earth science (*Erdkunde*) in relation to nature and the history of man; or general comparative geography as the firm foundation of the

study of, and instruction in, the physical and historical sciences." The destiny of the human race is irrevocably linked to the natural environment and the characteristics of the environment are embodied in the individual peoples. "Every man is the representative of his natural home, in which he is born and brought up. The fatherland is mirrored in its people." Working on this basis, which is for him strongly reinforced by his religious outlook, Ritter comes very close to a theory of geographical determinism, i.e. the overruling influence of geography on the life of man.

While we may consider that Ritter, by giving this subjective twist to his researches, commits a great disservice to the future of geography, we must balance this by recognition of his lasting merits. His general treatment of the physical sciences is similar to that of Humboldt: his individual contribution is to initiate systematic regional studies. In his view, the varieties of the physical relief, operated on by the "fluid" elements (water, i.e. the oceans, air, i.e. climate, and fire, i.e. volcanic action, etc.) produce combinations of mineral, vegetable and animal resources which form individual units, and it is within these units or regions that the divisions of the human race live out their history and from which they derive their characteristics. From the contacts of these geographically diverse regions (cf. the clash of cultures) proceeds historical diversity and so, in due course, cultural advance. However rash these speculations are, or appear to be, his conception of regional geography eventually proved fruitful: combined with, or in conjunction with, Humboldt's masterly treatment of the physical aspect, it is scarcely too much to claim that his work is the starting-point of modern geographical thinking.

CHAPTER FIVE

Geography Finds Itself

In the nineteenth century geography became an established discipline. At the century's close the world was known to man. It is true that there were some considerable areas unexplored, but the characteristics of these were known in general, and they could hardly contain any major surprises. At its close the content of geography—as a science and an art—had largely been agreed, and geographers were working along the lines upon which the study is now firmly established.

One of the greater, perhaps the major, scene of activity was Africa. For centuries, the continent, in the eyes of Europeans, provided essential staging-posts on the route to the Indies combined with trading stations which, from ignorance and neglect of the climate, took a frightful toll of the European merchants. South of the Sahara there were only three areas which had interested Europeans to any great extent: the southern extremity where the Dutch, and subsequently the British, had a permanent settlement and were beginning to penetrate northwards, and the south-east, where Portuguese officials and traders had penetrated into the lower Zambesi basin, and had obtained some gold from areas in what is now the Rhodesias. But the course of international politics and their declining power had prevented them from establishing effective control.

Africa, however, had one available resource which was being ruthlessly exploited—the hundreds of thousands of human beings who supplied the energy which sustained the European colonization of Brazil, the Caribbean islands and the mainland to the north. The triangular Atlantic trade was one of the props of Europeans in the new world and of their home economies. Its place in British economic development is a familiar story; cloth, trinkets, arms and spirits were exported to West Africa; the slaves obtained in exchange were

transported to the new world; there they were exchanged in turn for the sugar, rum, tobacco and other exotic products which flowed back to Bristol, Liverpool, and London to stimulate the British economy. On the east, a similar, but less extensive and organized trade also flourished under the control of Arab potentates linked to the Persian Gulf. Otherwise, except for Egypt and to a lesser degree Ethiopia, interior Africa was veiled in a mystery which Europeans had no incentive to dispel.

From about 1780, and especially after the Napoleonic wars, the position changed with growing speed. Scientific curiosity came to regard the unknown interior as a challenge, interest first focusing on the century-old problems of the sources of the Nile and the course of the Niger. The industrial masters were attracted by the possibilities of opening up markets, particularly when rumours of a populous region, vaguely associated with the city of Timbuktu, began to circulate. Then British public opinion under the impact of the humanitarian and evangelical revival rebelled against the evils of the slave trade and, having abolished it, sought to carry their campaign into the interior—compelling the West African merchants to find a fresh basis for their traffic. Finally territorial ambitions, stimulated by the French presence in North Africa, added their share to the revolution which burst over Africa. Throughout this scramble for Africa, official Britain sought to avoid territorial commitments, and generally it was with extreme reluctance that the home government was pushed into assuming responsibility for the territories into which their missionaries and traders had so resolutely pressed.

Among the hundreds of explorers certain names and exploits are outstanding: Mungo Park, the Scottish physician, meeting his death while descending the Niger by boat; René Caillé, the young Frenchman, who in disguise reached Timbuktu, and joining a caravan crossed the desert to the Mediterranean, to be received with scepticism and derision; Krapf and Rebmann, the German missionaries, whose report on sighting the snow-capped summit of Mount Kenya was almost as strongly discredited; the saturnine Richard Burton, with the temporarily blinded John Speke, suddenly catching sight of the waters of Lake Tanganyika, the first Europeans to do

so; Speke later marching doggedly round Victoria Nyanza and solving the Nile problem by locating the exit of the Nile at the Ripon Falls.

All these have their perennial fascination: but without any doubt the name which immediately captured, and has ever since held the affection of the British public, is that of David Livingstone; the Scottish mill-boy who qualified as a doctor and, seeking a missionary field, turned to southern Africa when China was barred to him; who, harried by the Boers and depressed by the apparently small fruits of his missionary labours, set out northwards to defy the slavers and to open central Africa to Christianity and the commerce which alone could support a stable and progressive civilization. Within twenty years he had crossed Africa from west to east, traced the course of the Zambesi, discovered the Victoria Falls, put Lake Nyasa firmly on the map, and made a considerable contribution to the geography of the Central Lakes region. It was the same man who was stricken with remorse when his wife died of fever on the Zambesi, who was shattered by self-disgust when circumstances involved him on the Arab side in a one-sided and bloody conflict with Congo natives, and who died, racked with pain and broken by failure to locate the elusive sources of the Nile. This is also the man who never fired a shot in anger, to serve whom Africans were happy to travel long distances, and who so inspired his small band of followers that after his death they embalmed his body and bore it through hostile country to the sea. The power of his personality is also revealed in his relations with H. M. Stanley, in almost every way his opposite. After the famous encounter at Ujiji Livingstone and Stanley spent some months together, exploring the shores of Lake Tanganyika. This was probably the happiest time of Stanley's eventful life. Livingstone imparted to him much of his own love of Africa, which had already begun to grip Stanley and to impel him to dedicate his life to unravelling its complicated geography.

On Stanley's return to England, the blow fell which probably irrevocably altered his whole life; stung by the thought that an American and a journalist should have claims to be an African explorer, the geographers of Britain at first received

him with mockery, almost with derision; an unfortunate quip—"it was Livingstone who had found Stanley"—sums up the general attitude. Though reparation was made, Stanley, sensitive on the score of his lowly origin, never quite forgot. Unfortunately, his reception in New York, particularly at the hands of the newspaper proprietor who had sent him out, was accompanied by even more ludicrous incidents. But the man who had made the long disheartening journey from a Welsh workhouse to Ujiji was not the type to be quelled in this fashion, and he pressed on to establish his reputation as one of the greatest, if not the greatest, of African explorers. By charting the shores of Victoria Nyanza and by descending the Congo for the first time to the sea, he closed the chapter on the search for the Nile sources. But the determined and fearless man who battled his way against heavy odds down the Congo, who on a later expedition quarrelled with his lieutenants and finally gained the Congo for the wily King of the Belgians, was not, it is safe to say, the man who had sat at the feet of Livingstone and dreamed of carrying on his life work. It would be too rash to assert that the Belgian régime in the Congo owed anything to an inept and hurtful gibe, but it would be equally rash to suppose that Stanley's attitude to Britain exerted no influence on subsequent events.

After Stanley, the stature of the African explorer inevitably declines, though there is no lack of vivid, devoted and able characters; Joseph Thomson, the youthful inexperienced Scot, who on the sudden death of his leader, assumed command of the R.G.S. expedition of 1878 to the Central Lakes, and later, through his personality and sense of humour, penetrated the territory of the warlike Masai; Mary Kingsley, that unusual product of a Victorian household, who travelled the rivers of French Guinea on her scientific pursuits, getting on equal terms with the peoples and, rather surprisingly, siding with the traders against the missionaries on the question of their welfare. As the century progresses, the type of traveller inevitably changes; and the administrator and scientist enter the field. Among the former is the intriguing figure of H. H. Johnston (later Sir Harry) who combined the painstaking industry of a Teutonic Barth with a humane and broad outlook. [illegible]'s is the now rather overlooked figure

of the geologist, J. W. Gregory, the first to reveal the nature of the Great Rift valley of East Africa.

To contemplate such names as these is not a mere exercise in blind patriotism, or an indulgence in heroics. What these men did, where they went and why, has left an indelible mark on present-day Africa. Independent Uganda is the end result of the search for the Nile sources combined with missionary zeal. Many political and other conditions flow from one main divide in Central Africa, between the former territories of the French and British empires. Kenya fell to the latter because of the pioneering work of Speke, Burton, Grant, Thomson and their successors. The pioneering spirit of these men, combined with the reluctance of the home government to become deeply involved in Central Africa, led to the establishment of a form of government which, however it may be criticized, had within it the power of evolution, and is justified by the record of independent states such as Nigeria. While laying the foundation of the future, these men also, as they mapped the country they were traversing and observed its physical features and its varied and to them exotic life, helped to break down the insularity of Britain, widen her horizons and bring her face to face with world problems.

The exploration of Australia, also accomplished within the century, was less dramatic and tortuous. There it was the conquest of an empty land, uncomplicated by the presence of large settled populations. Despite its position and the variety of its regions, it was a land in which on the whole the immigrants from the British Isles felt themselves at home from the first, and for whose future, until experience taught them a truer appreciation, they were apt to entertain exaggerated hopes. Its story falls into two chapters; the establishment of the first settlement around Port Jackson, the break through the Blue Mountains into the plains of the south-east with their westward flowing rivers, and the establishment of other coastal settlements at sites offering good access by water. The second chapter relates the penetration and crossing of the interior. There are few sensational incidents, if the disastrous course of the Burke and Wills expedition is excepted. Thus there are no catchpenny titles in Australian historical geo-

graphy to parallel "The siege of the South Pole" or "The conquest of the West". Nor was there much mystery about it; for a time the theory of a great central sea, splitting the continent in two, compounded of scraps from Dampier who thought there might be a passage from the north coast, and speculation on the destination of the west-flowing rivers, stimulated exploration. But after E. J. Eyre in the years 1840-41 had demonstrated the character of Lake Eyre, and had walked overland from Adelaide to Perth, the vision disappeared.

Progress was steady and usually unspectacular. The first serious advance was made by Charles Sturt when he pushed doggedly towards the centre of the continent. In little more than twenty-five years, John MacDoual Stuart, following in his tracks, had gained the shores of the Timor Sea near modern Darwin. Shortly before, Burke and Wills had reached the Gulf of Carpentaria, only to perish on the return journey mainly through bad organization and defects of leadership. The first to make a similar journey and survive was John McKinley who in fact preceded Stuart by some weeks. The reason of the generally unspectacular course and final triumph of Stuart and those who carried on his work, is no mystery. These expeditions were not conducted by Indian army officers on leave or by adventurous characters with a scientific bent and little experience in the field, as were some of the contemporary African expeditions, but by experienced bushmen with a first-hand acquaintance with the hazards to be faced. In the country-bred horse they had the best means of transport for their purpose. As self-supporting units, they were at least spared the trials of their African fellows, who were dependent on long trains of native carriers whose needs disrupted the economy of the districts through which they passed The trials of Eyre had shown the futility of attempting such journeys on foot, and one of the prime causes of Burke's fate was the absence of an experienced traveller from his team. Their contemporaries were practical men with a practical goal in view, the pioneering of fresh cattle country and of a trans-continental route. Their backers were the cattle-owners and State politicians, anxious not to be outdone by their rivals.

This type of exploration had its shortcomings; the fact that these men succeeded generally meant that they had traversed the country in a favourable season; consequently their reports on the potentialities of the new country tended to be over-enthusiastic. This tendency was reinforced by the absence of scientific personnel in the earlier journeys. Apart from his general account, Stuart brought back a route survey which though generally accurate in its positions, lacked even any determinations of heights. His prophecy that northern Australia was destined to become a great cotton-producing country has yet to be fulfilled. It is partly this history, plus national feeling, that later led to bitter denunciation of those who referred to the "dead heart of Australia" and it was left to Griffith Taylor in the opening decades of the following century to demonstrate, as in other continents, that there was a boundary to permanent settlement, and that this was more restricted than the optimists would admit.

What the history of Australia demonstrated to the geographer was that a European people is capable of transporting and of establishing itself in a country of markedly different characteristics to its homeland, if it possesses the necessary toughness and adaptability. Developments in Queensland have shown that a white population can establish itself as a working community even within the tropics. Australia is in fact an excellent subject for study by the geographer who wishes to test general principles. It is sometimes carelessly said, for example, that the marginal distribution of population and its concentration in and around a few great cities is a special weakness of the Australian economy; but a little reflection will show that precisely the same factors account for the growth of many other great concentrations —Buenos Aires, Calcutta, New York, London and elsewhere.

In a later chapter, something will be said of the course of Antarctic exploration and its relation to the contemporary world. Sufficient however has been suggested here to indicate how dramatically European interests expanded in the nineteenth century, to bring virtually the whole world within its "sphere of influence." This astonishing outburst of human activity affected not only the material conditions of the

colonizing powers, but transformed their attitude to the world. It is no surprise therefore that it also affected the natural sciences and the study of geography.

The year 1859 has a special significance in the history of geography. In that year Alexander von Humboldt died, at a great age and occupying a position in geography which few, if any, had held before him. In that year Charles Darwin and A. R. Wallace published the theory which was later developed, on Darwin's side, in his *Origin of Species*, a work which influenced all subsequent thinking on the world of nature, and not least on geography. Darwin's achievement was not to propound the theory of evolution but to provide a theoretical explanation of why it occurred and how it worked. Many observers before him, from the study of fossils, the breeding of plants and animals, the fluctuations of population growth, and numerous other subjects had concluded that evolution occurred. Darwin provided the key—natural selection, through the struggle for existence and the survival of the fittest. That the whole question was very much in men's minds is plain from the fact that Wallace had arrived at this conclusion simultaneously. The importance of Darwin's work for geography must be summarized very briefly here.

The key passage for geographers in the *Origin of Species* is: "As many more individuals of each species are born than can possibly survive; and as, consequently, there is a frequently recurring struggle for existence, it follows that any being, if it vary however slightly in any manner profitable to itself, under the complex and sometimes varying conditions of life, will have a better chance of surviving, and thus be *naturally selected*." (Darwin's italics.) In his chapter on geographical distributions, he writes: "The dissimilarity of the inhabitants of different regions may be attributed to modification through natural selection, and in a quite subordinate degree to the direct influence of different physical conditions." On the latter point he is more emphatic elsewhere, maintaining that similarity or dissimilarity cannot be accounted for "by climatal and other physical conditions." In his view the important factor was the relationship of "organism to organism," and from this sprang his concept of the struggle for existence.

In the course of this struggle, the more highly developed and complex organisms survived the simpler forms.

In studying the New World, Darwin pointed out that it was possible to find many areas displaying similar geographical conditions yet possessing utterly dissimilar faunas and floras. Again, he called attention to areas remote from each other of which the faunas and floras, though specifically distinct were clearly related to each other. He quoted several instances, for example: "The plains near the Straits of Magellan are inhabited by one species of Rhea (American ostrich), and northwards the plains of La Plata by another species of the same genus; and not by a true ostrich or emu, like those found in Africa and Australia under the same latitude." He then posed the question: "What is the deep organic bond, prevailing through space and time, over the same areas of land and water, and independent of their physical conditions?" The answer he supplies is inheritance modified through migration. "Widely-ranging species, abounding in individuals, which have already triumphed over many competitors in their own widely-extended homes will have the best chance of seizing on new places, when they spread into new countries. In their new homes they will be exposed to new conditions, and will frequently undergo further modification and improvement; and thus they will be still further victorious, and will produce groups of modified descendants." In this process he recognized that barriers to migration become of high importance, and it is in this connection that "geographical and climatal changes" re-enter the scene. To sum up, each species has originated in one area alone and has subsequently migrated "as far as its powers of migration and subsistence under past and present conditions permitted."

When Darwin tackled the question of geographical barriers, he recognized that mountain ranges could check the spread of species, but by invoking a widespread glaciation, based on the work of Lyell and other geologists, he argued that similar mountain floras, found on the highest regions of isolated ranges, were survivals of the glacial period and had formerly been united. He also appealed to the geologists, by invoking former land bridges and the connection of islands with the neighbouring continents, to support his contention that

species had their origin in particular areas and had migrated at one time or another to their present abodes. In dealing with island faunas and floras, he also argued for dispersion by accident, through drifting or transport by birds. He refused to entertain the idea of continental drift.

The theory of natural selection provided an attractive framework into which contemporary scientists fitted a vast number of facts. Its effects upon the advance of geography were varied and stimulating. It encouraged the study of crustal movements and the formation of continents, in relation to dispersions, and also of the "ice age." By its emphasis on the time factor in the study of man on the earth, it welded history and geography into an even closer association. It also inspired a more thorough investigation of his environment, which was at least the battlefield on which the struggle for existence was being fought out. But in the long run, it was by firmly placing man's evolution in the foreground, and treating him, physically and materially, in the same category as other forms of life that he enriched the study of geography, despite any modifications of his arguments which later investigations have introduced.

This influence was at first slow to make itself felt. Under its impulse, botanists, zoologists, geologists and other practitioners of the natural sciences went energetically to work in all parts of the world, collecting and systematizing innumerable facts. For the moment, however, it had less effect upon geography, except in so far as it gave fresh impetus to exploration and travel. This pause had two main circumstances: Carl Ritter, the contemporary of Humboldt, founded no permanent school of disciples, and his geographical theories, with their almost theological interpretation of the role of man on the earth, fell into disfavour with the advance of the new and more scientific outlook of historiography; later, as it will be seen, they were to be revived, though with a considerable difference. The influence of Humboldt persisted, with its emphasis on observation and correlation, and inspired men like Barth, the tireless African traveller, H. W. Bates, the botanist of the Amazon, and perhaps most significantly, the German geographer, von Richthofen, who did for China very much what Humboldt had done for Spanish America. But

man, his life and history in relation to the environment, had to wait longer for the concentrated attention of the geographer. At first, indeed, this field was almost occupied, to his exclusion, by the ethnographer, the anthropologist and the newly emerging sociologist. Generalizing perhaps a little too broadly, it may be said that the latter looked rather to men—their physical development, customs, social organization and culture —to explain differences and resemblances in their lives and their distribution over the earth's surface. To some extent, those who are now called "human geographers," forced on the defensive, stated their case in too extreme a form, and found the answer to those problems in the domination of the geographical elements of land and climate. In this type of argument, the extremists would maintain, for instance, that all islanders are hardy, and brave, and make intrepid seamen.

The development of this line of thought, though argued with much more subtlety and a terrifying mass of details, was strongest in Germany. There, Friedrich Ratzel attempted to show that men in groups, communities, or nations had spread, flourished and declined in a similar manner to animal and plant associations or communities. Though few would now go as far as Ratzel, it must be conceded that modern geography owes much to the stimulus of his ideas and the great mass of facts that he industriously and conscientiously recorded. He was, however, in fact attempting a task of collection and correlation which had by his day passed beyond the power of any one man to accomplish. Unfortunately, too, for his reputation, his theories were developed in an unscholarly and unscrupulous way by some of his successors, and found their ultimate expression in the slogans of the Nazi geopoliticians —"Lebensraum," "Drang nach Osten"—and, fundamentally, in "Ein Volk, ein Reich, ein Fuehrer."

This form of "geographical determinism" flourished quite vigorously in the late nineteenth century, for it fitted in with a strong philosophical trend. From Karl Marx came the heady theory of dialectical materialism, with all its implication for men, their lives, thoughts and destinies. If the universe can be simply explained by the phrase "matter in motion", controlled by "natural laws," then clearly there can be no other relation between man and his environment but one

inheritable. If the variation makes no contribution to survival, the organism perishes. What causes the variations has still to be elucidated, and a further problem relates to hereditary and acquired characteristics. It should be noted, however, that as far as modern man is concerned, no specific change has occurred, that is, no type has been produced which will not breed with its immediate progenitor. Bodily changes have, however, occurred in response to new physical conditions, e.g. with Europeans in the tropics, but these are not specific.

In the United States for a time, Ratzel's school exerted a special influence through the work of Ellen C. Semple. Miss Semple had attended Ratzel's lectures at Leipzig and later worked in close co-operation with him. For many years she had planned an English translation of his *Anthropographie*, but what finally emerged was part translation and part development of his ideas. Her *Influences of Geographical Environment* (New York, 1911) omitted Ratzel's conception of the state as an organism, but in other respects went very far towards geographical determinism. Isolated extracts are usually unfair, but the following eloquent passage conveys the flavour of her work. "Man is a product of the earth's surface. This means not merely that he is a child of the earth, dust of her dust, but that the earth has mothered him, fed him, set him tasks, directed his thoughts, confronted him with difficulties that have strengthened his body and sharpened his wits, given him his problems of navigation or irrigation, and at the same time whispered hints for their solution." Even if we overlook for the moment the general drift of the argument, is it frivolous to ask such questions as "What has the earth whispered to the tribes of the African tropical rain forest—and why apparently did it whisper something different to the pioneers of the American West? When the explorer sets out for the Pole, is the earth mothering him, whispering to him the solution of his navigational problems, or setting him a task, perhaps beyond his powers?" The book's influence, though considerable at the time, has waned, and few American geographers, for reasons which will appear later, would now maintain that man is "a product of the earth's surface."

An opposing school of geographical thought developed in France, partly out of the work of Carl Ritter, and partly

influenced by the new study of sociology. The great geographical "variety within unity" of the land of France, characterized by the numerous small regions, or *pays*, had long been recognized, and also the special way of life associated with each. The French geographers proceeded to examine this relationship between *pays* and local life, and reached the conclusion that each *pays* presented a set of possibilities, which had, or had not, been exploited by its inhabitants, and, equally, a set of difficulties, some of which they had been able to overcome and others they had been obliged to accept.

Many of these "natural" *pays* had already been studied by French geologists; as Vidal de la Blache pointed out, the "Paris Basin" was a term long familiar to geologists before it was adopted by geographers, who were also confronted for some time by the "Massif Central" before they recognized its significance. Parallel with this growing appreciation of the physical basis of geography, the study of sociology, much influenced by Darwin, was making rapid strides in France. As early as 1855, Le Play had published his great work *Les Ouvriers Européens* in which he propounded his theory of "Place, Work and Family" as the primary constituents of communities. It was Paul Vidal de la Blache (1854-1922) who united these two strands to found the great French school of geography and to infuse it with that humane spirit which it has never renounced.

With the advance of technology, difficult elements in the environment could be reduced, and conversely, certain exploited possibilities, by changes in economic or social habits, could become unprofitable or even valueless. In this trend of thought the influence of Darwinism is also to be seen. It also emphasizes the growing importance of the historical aspect of geography. Many changes in cultural landscapes have been due to new systems of landholding, to demands for new products, or to variations in the rate of population growth. In this way, in opposition to determinism, the French school set up "possibilism." Speaking broadly, this is now the generally accepted outlook, though more determinist geographers will only concede "stop-and-go" possibilism, i.e. nature changes the traffic lights and man acts accordingly. However, it should be obvious from what has been said that

man has often shared with nature the operation of the lights, and that they have been operated very irregularly!

As Vidal de la Blache travelled, observant and fired with a true patriotism, through the land of France, these *pays* became living realities to him, not simply as portions of a landscape but as vital elements in the lives of his countrymen. In 1888, he wrote, in an exposition of his geographical creed, the following lines, which, it is scarcely an exaggeration to say, are the foundation upon which a great school of geographers was to be built. He is describing a journey in imagination through France: "Between Etampes and Orléans, we cross by rail a *pays* called the Beauce. Without leaving the carriage door, we can distinguish certain characteristics of the landscape; a soil absolutely level, over which stretch long ribbons of cultivated fields; very few trees or streams (in 45 kilometres not one has been crossed), no isolated dwellings; all settlements grouped in towns or villages. If we cross the Loire, we find to the south a country just as flat but with soil of a different colour, where woods and pools abound; this is the Sologne. To the west of the Beauce, between the sources of the Loire and the Eure, there is a hilly country, green, broken by small enclosures and rows of trees, with dwellings scattered far and wide. This is the Perche. We enter Normandy. If, in the Department of Seine-Inférieure, we examine the two neighbouring *arrondissements* of Yvetot and Neufchâtel, what differences we find. In the first, all is flat; fields of corn, farms enclosed within squares of great trees, wide horizons. In the second, nothing save little valleys, quick-set hedges, and pastures. We have passed from the Pays de Caux to the Pays de Bray. The mode of living has changed with the soil."

Here are all the topics later developed by himself and his pupils; the physical basis—geology, soils and hydrography; vegetation—tree-rows, hedges and woods; human geography—cultivated fields, pastures, scattered farm houses, compact villages—the whole welded together to make up the territorial units within which flourished distinctive ways of life. Here we have the germ of all those regional monographs by his pupils which are the glory of French geography.

But Vidal de la Blache drew an important conclusion from his studies of the countryside and of the world overseas.

He saw that the "way of life" in rural Western Europe had been relatively stable for several centuries; overseas, however, the nineteenth-century picture was one of continual change, destruction and recreation. Indigenous cultures vanished before the European invader—trader, settler or empire builder. In their place there grew slowly other ways—the life of the ranch, the farm, the plantation, the cities of industry; great tracts of forest fell before the axe of the lumberman or gave way to the coffee or rubber planter; the plough of the settler broke up the firm grassy turf established over the centuries, and, under favourable conditions, exotic cereals were grown (where the conditions were unfavourable, the topsoil from the hedgeless fields was blown away over the ocean); the indigenous wildlife fell before the hunters, the innumerable herds of buffalo and caribou were indiscriminately slaughtered, often to be replaced by European breeds of cattle; the jungle path, the prairie trail, the river portage were replaced in time by the all-seasons route, the railroad, the canal; in areas scarcely disturbed by man arose blast furnaces and Blake's "dark Satanic mills." Across the seemingly pathless oceans plied liners and freighters, to transform the economies of Europe almost as drastically as they had revolutionized those of the new lands. And what of the indigenous peoples, the thinly scattered tribes of the temperate regions, the struggling masses of the monsoon lands? Some disappeared completely; others were herded into reservations, or continued their age-old existence beyond the limits of settlement or exploitation; elsewhere they found themselves the servants of the new régimes, in mine, plantation or factory. Where there was less disparity in numbers, the indigenous peoples held their own—in the long run virtually absorbing the newcomers, to evolve a hybrid culture, or maintaining a varying degree of independence not completely immune from the ways of the strangers, until, with another revolution in world affairs, they could exert their independence again, in contact with the outside world or in stubborn, often sulky, isolation.

There is, of course, another side to this picture, at least if we look at it from the point of view of Man, as opposed to groups of men. Judged purely by a statistical standard, the earth, as the home of man, is organized more efficiently than

ever before, since it now maintains at least twice the population it supported a century ago. This has been achieved through many channels, the increased and, on the whole, more efficient use of resources, the unleashing of enormous supplies of energy, the development of new skills and techniques, the assault on disease, the advance in international co-operation. But every new development brings new problems. No more than any other man, can the geographer offer a ready made solution; he can, however, make his special contribution.

This may appear to be wandering far from Vidal de la Blache, but it is implicit in all his work. When he turned his attention again to France, he saw the beginnings of a similar, but less painful, process at work. As a result of the industrial revolution, urban centres were growing rapidly, and, through the demands of industry and the needs of their populations, were transforming her relations with other countries, destroying her traditional agriculture, and disturbing the balance between town and country. The effects were visible in the changing face of France; new crops, new systems of cultivation, a redistribution of settlements, a new network of communications, a drift to the towns and rural depopulation, and, with these changes, new ways of life, new but still related to the geography of France.

From this he concluded that in France, just as in the new lands, ways of life were subject to change, though the *tempo* might be less violent. In seeking to understand a human region therefore, history cannot be neglected; in this field, as in any other geographical study, it was necessary to apply the theory of evolution. As a result, history and geography came together on a far sounder basis than in the days of Carl Ritter. This reconciliation has been the hall-mark of the French school, and its effects are apparent in many other countries today.

Vidal de la Blache did not exaggerate the pace of such changes, recognizing that man is a creature of habit rather than of initiative. He saw clearly that the most conservative way of life must give way before a sufficiently brutal shock from outside. He might have gone further and reached the conclusion that such shocks are not caused solely by material

changes; an intellectual shock, such as that administered hy Charles Darwin, triggered off as violent reactions as did the industrial revolution.

This engagement in regional geography with a historical background did not cause Vidal de la Blache to disown or underrate general geography.

The same physical and biological principles that the regional geographer observed at work in the *pays*, must be studied on the grander stage of the earth as a whole. The mutual help and experiences of the general and the regional geographer fructify the whole study of geography. Fundamentally, his guiding principle was unity—as his aphorism, "France . . . is not a machine which can be dismantled and explained piece by piece", demonstrates. Similarly, during each stage of its evolution, the environment in which every community or culture lives, offers to man "manifold possibilities of intervention and opportunities for initiative."

Since this French school set geography on its present course, I shall dwell very briefly on later developments. In Britain, where for various reasons progress in geographical theory was slower, the German school of Humboldt and Ratzel was at first influential. This may be seen, for instance, in the work of Halford Mackinder, whose unbounded energy and gift for brilliant and stimulating generalization are indelibly impressed upon British geography. But the influence of French thought gradually exerted itself. A. J. Herbertson, the second prominent name, with his scheme of "natural regions" and "macro-organisms," was closer in spirit to the French, though he avoided their sometimes excessive absorption in historical minutiae. For a time, indeed, British geographers resisted the trend towards placing man in the foreground and were almost prepared to abandon him to the sociologists. But a more balanced approach has developed, and the major contribution of historical geographers, for instance, has conferred distinction on the British school. On the other hand, there has been increasing realization of the danger, as one distinguished geographer has phrased it, of "taking the ge- out of geography." (If that were done, it would mean, by definition, the destruction of geography as a serious discipline.) Physical geography is certainly not neglected, particularly the study

of land forms by geomorphologists. In the United States, on the other hand, the tendency is rather the opposite. Geomorphology, despite the great contributions of American geographers in the past, has largely been abandoned to the geologists, and geography has sometimes seemed in danger of sliding into a rather amorphous brand of social studies.

This chapter has perhaps concentrated too much on theory or methodological considerations. A good working definition of geography, after all, is "what geographers do." In the following chapters, a necessarily restricted attempt is made to convey some impression of the variety of their work and its relevance to the world today. To place this in perspective, it is essential to understand the fundamental unity of their varied tasks. If this chapter has brought this home to the reader, it has not been written in vain.

CHAPTER SIX

The Geographer's Tools

We have learnt something of the material with which the geographer deals and of the way in which he assembles it. We may now look at these rather more closely, paying particular attention to the practical aspects of his study. Geographical knowledge was first acquired by travel; at least all the earliest geographers of note were travellers, from Herodotus, the first to describe to the Greeks the strange behaviour of the river Nile, which came down in flood during the driest months of the Egyptian year. These early travellers followed established routes, depending on local means of transport, and picking up information and news from those they chanced to meet on their travels. Their primary motives were simple—trade or religion, occasionally curiosity.

It is not necessary to deal with the earlier travel literature in detail. It has been summarized in Chapters II and III. The present purpose is to outline developments in the assembling and recording of data by geographers. By the middle of the eighteenth century, mainly through the influence of French philosophers, it was no longer considered adequate for the results of an exploratory voyage to be included in a general narrative. Such narratives were usually the work of the commander, and were mainly based upon the ship's log. When astronomers and other scientists were added to the ship's complement, it was at first the practice to put tables of positions, magnetic observations, lists of plants, animals and minerals in appendices at the end of the volume.

The first great series of "scientific results" was the thirty volumes in which Humboldt and Bonpland recorded the vast amount of observations they made on their journeys in South America and Mexico. These were lavishly produced, in limited numbers, with the unfortunate result that complete sets are now very scarce. The Pacific voyages of exploration in

the early nineteenth century were recorded in similar fashion; the records of the French explorer Dumont d'Urville's voyage ran to fifteen volumes; and a similar series for the American Charles Wilkes appeared in as many volumes. An early British example, on a smaller scale, is the three volumes by Charles Darwin on the voyage of the *Beagle*. Britain however was placed well in the fore with the magnificent series of seventy volumes which embody the findings of the *Challenger*'s oceanographic expedition of 1872-75.

It is at first sight strange that, in Britain at least, it was long before the results of land journeys were published on so lavish a scale. The reasons, however, are clear. The oceanographic expeditions were generally carried out by the Royal Navy, and the Admiralty, to its credit, was prepared to accept the financial burden of publication. The explorers by land, however, had no such generous patron. It is true that H.M. Government, often reluctantly and under heavy pressure, could sometimes be induced to grant a little financial support to an expedition, as in the case of David Livingstone's Zambezi expedition in 1863-67, but it was careful to place a limit on its liability, and, as far as I am aware, it never made the publication of results a condition of its grant-in-aid. It was in fact usually eager to divest itself of responsibility and to entrust the organization and control to the Royal Geographical Society. The reason lay in British imperial policy in the nineteenth century—the reluctance of the home government to commit itself to a forward policy in relation to colonial expansion, and a consequent fear of becoming embroiled with other nations through incursions into the "blanks on the map." In typical Victorian fashion, the publication of geographical knowledge thus acquired was left to private enterprise. It is true that the War Office was interested at first hand in collecting geographical information—particularly after the revelation of shocking ignorance which followed upon the Crimean War—but, for obvious reasons, their intelligence reports were treated as confidential, and their content never, or only slowly, reached the general public. To be fair, it must be remembered that it was the Corps of Royal Engineers which was the inspiration and mainstay of the mapping not only of the

British Isles, but of much of the colonial territories, and that it exerted great influence on the work of the Survey of India. One of the greatest contributions to geography has been the charts of the Hydrographic Department, Admiralty and the maps of the Ordnance Survey and the Geographical Section, General Staff.

Left largely to his own devices, the returned British explorer could do little but publish a one, or two, volume work on his experiences for the general public, hoping to recoup some of his expenses or even to keep body and soul together by bringing off "a best seller." The results of this on Polar exploration have recently been demonstrated by L. P. Kirwan in his book, *The White Road*. The corresponding symbol to the "polar hero" was in African exploration, for example, the lone traveller either battling against thirst and sand storms in a romanticized desert, or, racked by fever, hacking his way through the tropical forest pursued by active, cunning and blood-thirsty natives. This figure derived largely from an amalgam of James Bruce, half-buried in a Nubian sand storm, Gordon Laing butchered near Timbuktu, and H. M. Stanley, forcing his way down the Congo or crashing through to the relief of Emin Pasha.

This attitude towards travel is in part an interesting by-product of the Romantic movement. As Bertrand Russell has commented: "In his [Rousseau's] disciples' novels and stories, we find wild torrents, fearful precipices, pathless forests, thunder-storms, tempests at sea, and generally what is useless, destructive and violent. This change seems to be more or less permanent; almost everybody nowadays, prefers Niagara and the Grand Canyon to lush meadows and fields of waving corn. Tourist hotels afford statistical evidence of taste in scenery." And he adds: "The geography of the romantics is interesting; from Xanadu to the lone Chorasmian shore, the places in which it is interested are remote, Asiatic, or ancient." While it would be too sweeping to apply this dictum to all the British explorers, it is safe to say that it animated the crowds who flocked to lionize them. In so far as this feeling inspired their journeys, it was beneficial; but in misplacing the emphasis

on their achievements, it contributed to hold back the development of geography in Britain. The narrative of such exploits was not the place to find careful compendiums of scientific facts, though their pages are full of illuminating detail of the African scene as recorded by alert and candid observers steeped in the standards of the Victorian age. In the pages of David Livingstone or Mary Kingsley are innumerable facts worthy of the attention of all geographers. Where, then, are to be found what we may call, for want of a better word, the serious records of nineteenth century geography? The answer is in the periodical publications of learned Societies, and in particular in the *Journal* and *Proceedings* of the Royal Geographical Society. Therein are to be found records of most British explorers from 1830 onwards, often accompanied by valuable maps. Other sciences were catered for by the Geological and Zoological Societies. Physical geography, in so far as it was differentiated from geology, was also the province of the *Journal* of the Royal Geographical Society, but it was not until the end of the century that it received full treatment in the expanded *Geographical Journal*. To these sources must be added the innumerable series of statistical year-books, and memoirs poured out by government departments in most countries of the world. Similar publications and periodicals were also produced in Europe and the Americas.

This brief survey will demonstrate the difficulties facing those in charge of a geographical library attempting to be at all comprehensive, and, by the same token, the student working on a particular country. The task, however, is now much lighter, with the founding of numerous specialist publications, and also through the work of the various branches of the United Nations Organization in standardizing and collecting much statistical information and in stimulating co-operative studies. But it is still often a source of surprise to discover how little is known with precision of many areas of the world. Such are the sources, apart from work in the field, of much material for systematical geographical study.

There is another class of material which has almost as distinguished and as long a lineage, namely maps. Cartography demands detailed treatment here, for its importance is often succinctly expressed in the dictum that "maps are the

characteristic tool of the geographer." For some reason, this opinion often seems to irritate geographers; apparently because maps can be employed in research in many other sciences. (One also suspects that another reason, less overtly expressed, is that they demand some knowledge of mathematics.) But, if geography is in the broadest sense the description of the earth, then maps are peculiarly within the province of the geographer. The written record is one method of preserving and interpreting geographical facts; the map is another, and one moreover which has its own special contribution to make. Furthermore, in earlier ages and with primitive peoples, maps are often the most important geographical documents to have survived.

It would be foolish to attempt here an outline of the history of maps, a potted synopsis of cartography, or a guide to map interpretation. But a number of points can usefully be made. A map is a proportional representation of a particular area of the earth's surface on a plane, in which certain conventions are used. From this very generalized definition, certain consequences follow. Since the earth is, more or less, a sphere, it is obviously impossible to map a portion of it with absolute accuracy on a flat sheet. The three main features of maps are scale, direction and area (including shape), and it is possible to produce any two of these on a sheet of paper; within limits scale and direction can be correct, if so the area will be inaccurate and shape consequently distorted; similarly scale and area can be correctly represented, in which case direction will not be true. If one examines one half of a globe (or hemisphere) in which parallels and meridians are marked, the parallels appear as straight lines equidistant from the Equator, and the meridians as curves converging at the poles. The science of constructing a projection lies in placing these lines on a sheet of paper, in such a way that the desired properties can be obtained. A projection is in fact any orderly arrangement of parallels and meridians to serve a particular purpose. Some such arrangements can be obtained graphically, by projecting points on the surface of the globe on to a plane, e.g. for an azimuthal projection. It is clear from inspection of a globe that only one hemisphere can be projected in this manner; for this and other reasons the graticule for most map-

projections is calculated mathematically to give the required properties, and is not obtained by projection.

It follows from the above that before designing a world map (or indeed any map) the cartographer must know the purpose for which it is designed, otherwise the map may give an erroneous impression. Here it will be useful to refer to those world projections which are commonly found in atlases, with brief remarks on their properties and uses.

(a) The Mercator projection: this was formerly the most used projection. Sailors require a chart on which a bearing, or direction line between two points can be laid down as a straight line. This line must cut each meridian at the same angle, since all meridians converge at the Poles. The cartographer Gerhard Mercator (1512-94) showed that this could be ensured by making the meridians and parallels straight lines, and increasing the distances between the parallels *proportionately to the increasing distances between* the meridians. It will be seen that since the meridians are parallel, instead of convergent, areas must increase with distance from the Equator; the exaggeration of the area of Greenland as compared with that of India (they are approximately the same) can readily be seen on this projection. The Mercator projection is thus used when direction is the chief requirement, but is useless for representing comparative areas. It should however be noted that since it retains the correct angles it preserves the shapes of small areas.

(b) A class of projection which is useful for studying distances and direction from one centre is the azimuthal or zenithal. A common example is the polar azimuthal. Here the centre is one of the Poles, and the meridians radiate from it at the correct angles. As these lines never meet, and therefore cannot converge at the opposite Pole, the projection cannot usefully include more than one hemisphere, and distortion is considerable at the margins of the map. The distance from the centre to all points on the map is correct: therefore by making the centre, for instance, London, a map showing the direct air distances to other countries can be constructed. Similarly it is useful for orienting radio apparatus.

(c) Maps which represent areas correctly, while retaining

reasonable shape are more difficult to construct, particularly since they are generally required to cover the whole surface of the globe. As they cannot be constructed graphically, the design of a particular variety is a matter of mathematical calculation, to secure that the areas enclosed between parallels and meridians are correct in relation to each other. If it is desired to show (for example) the areas in the world under wheat, it is essential to use an equal area projection, otherwise the relative areas will be obscured. The projection often used in atlases is the Mollweide. It is found that by a slight adjustment of the parallels and meridians, the relation for example of the continents or the distribution of a particular crop can be more conveniently shown. As a result of this adjustment, it may happen that a continuous representation of the surface of the globe is not obtained. Such projections are known as "interrupted." They should not trouble the general reader, since they should be accompanied by a clear statement of their characteristics and purpose. As there is no limit to the number of projections which can theoretically be designed, he need not worry unduly over minor variations.

The above paragraphs will have achieved something if they have impressed on the reader the necessity of being clear about the purpose for which he requires a map and also of understanding the conventions used by the map-maker. One convention commonly used, for example, is to draw the Equator as a straight line, when in fact it closely approximates to a circle. In the course of time, map-makers have also evolved conventional ways of representing objects which occur frequently in the landscape. In atlases, for example, common conventional signs used are circles for cities (often graded according to their population), single continuous, or double, lines for roads, dotted lines for tracks, barred lines for railways, and so on. It is essential therefore to study the table of conventional signs carefully. The map-user should also understand that every map is, to a greater or lesser extent, a generalization. Clearly no map can show every feature of the countryside, consequently, the map-maker is confronted from the start with a choice of what to include. It is here that he must

bear in mind the purpose of the map; a road map for motorists will include many features of little interest to the hill-walker or climber, and *vice versa*. Generalization will also be forced upon him according to the scale at which he is working. Clearly, a heavily-indented coastline can be shown in considerable detail on a map on the scale of one inch to the mile; while an atlas map on the scale of 1:5 million (approximately one inch to eighty miles), a comparatively large scale for an atlas, cannot possibly show the same amount of detail. The map-maker must do his best to convey some impression of the character of the coast, and the ability to generalize skilfully is the hall-mark of a good cartographer.

Let us turn now to maps of relatively small areas of the earth's surface, that is, the kind of map with which the general reader is most likely to be acquainted. The first observation to make is that the question of the projection employed is not of vital interest to him; since the area is small, the curvature of the surface can be neglected, though for the technical expert it is still important. The points which concern the user are scale, direction and conventional signs, and these should be carefully studied before the map is used. The scale is usually expressed on British maps in terms of miles to the inch, and the representative fraction is usually given also. For example, one inch to one mile: R.F. 1 (inch): 63,360 (inches). Reference is sometimes made to "natural" scales: when the R.F. can be stated in round figures based on multiples of one thousand, e.g. 1:100,000 or 1:500,000. There is, however, nothing particularly "natural" about these scales. They are more usefully regarded as metric scales, and in fact are commonly employed in countries which have adopted the metric system. It is useful to remember, when travelling abroad, that the 1:50,000 scale is somewhat larger than one inch to one mile; the approximate equivalents of other "natural" scales can readily be calculated from this. It is also helpful, before using a map, to make a rough time scale, according to the method of travel. With a One-Inch Ordnance Survey map, one hour's walking equals approximately three inches; motoring at 40 m.p.h. with a Quarter-Inch map (four miles to one inch) is equivalent to ten inches on the map. It

will be seen that, in the latter case, it would not take long to run off a map sheet; consequently it is more convenient to have a smaller scale map for the main journey, with perhaps a quarter-inch map for details at the end of the journey. In travelling with a small-scale map, it is as well to remember the remarks above on the subject of generalization; it may, for instance, be impossible to find one's way through a large town with it, on account of the extent to which the road pattern has been generalized.

Direction is generally shown by some form of arrow which indicates true north, and a statement of the magnetic variation. Direction is not of such great importance to motorists, who begin by taking a main road and then depend upon sign posts, but the walker or hiker should orient his map at the start. This can be done easily with the aid of a pocket compass, the map being set out so that the magnetic north indicator is parallel to the compass needle, or it can be oriented approximately by the position of the sun.

Most maps give some indication of surface relief, that is the variations in the altitude of the surface above sea-level. The basic method used on Ordnance Survey maps is contouring, a contour being a line which passes through all points at a given height above sea-level. Contour lines, in the strict sense, have been pegged out and surveyed on the ground, or drawn optically from air photographs by photogrammetry. Where they have been put in less accurately, perhaps from eye-sketches, they are known as form lines. A student trained in map-reading and with a knowledge of land forms can derive much information from a well-contoured map, which enables him to form not only a clear mental picture of the characteristics of the area but also of its physical history. The general principle is that the closer the contours are together, the steeper is the slope. Where, for example, the lower contours are relatively widely spaced, then come together, and finally widen, the slope is convex. Working on these lines, it is possible to fashion, as it were, keys to the topography, so that one can determine the cross-section of a valley, or of a mountain range, the profile (longitudinal section) of a river-bed, the character of an escarpment, or the general slope of the region. From these and similar observations, it is possible to

say, for example, whether a valley has formerly been occupied by ice, or an upland region has been glaciated; whether a change of level has occucted and the rivers have been rejuvenated; if a coast is being eroded by the sea. A skilled eye can also learn much of the character of the local rocks; variations in the resistance of exposed strata to erosion will find expression on the topographical map; limestones have a characteristie topography, differing from that of the clay lands. These are some of the simpler conclusions to be deduced from a topographical map. To carry the study further, a geological map will be required, and perhaps detailed levelling in the area. But for the user with only a general knowledge of physical geography, a good topographical map can add much to the enjoyment of a holiday.

Physical relief is not the only subject which can be studied with the aid of a good topographical map. An obvious one is the character of settlements, in relation to site, water supply, communications, etc. Much can also be learnt from the area, shape and position of parish boundaries. If maps of a particular area are in existence which have been constructed at earlier periods, the student is enabled to trace out the historical development of settlement or the progress of economie exploitation. Since this aspect is referred to in some detail later, it is unnecessary to elaborate it here. Using existing maps as a basis, the geographer can plot many types of distributions, physical or human, but it is essential that (i) he is quite clear at the outset that the material at his disposal is suitable for this technique; (ii) there is at least *prima facie* evidence that the distributions he is proposing to map are likely to be related to each other; (iii) he does not accept, without further study, the apparent results of his mapping. He must be sure, for instance, that his population data are reasonably complete and correctly classified. More careful study might reveal, for example, that there were gaps in distribution, due to a special reluctance on the part of the inhabitants to impart the required information, to the fact that the count had been made at a certain period of the year when a proportion were temporarily absent, or that the information was lacking through a purely administrative mischance. He must also be sure that the unit of area he selects for a density map is appropriate.

If, for instance, the particular distribution is fundamentally related to proximity to rivers, a map plotting the distribution on the basis of large administrative units could be seriously misleading. Account must also be taken of statistical significance. If a disproportionally small number of units occur in one area it is probable that their occurrence is purely accidental. Finally a point to be made is that a distribution map of this type is not necessarily the final answer; it can however define the problem more clearly and suggest possible lines of research in the approach to the final solution.

It may be thought that much of the above is labouring the obvious, but it cannot be too often emphasized that if maps can be of major assistance to the geographer, they can also, if their basis is misunderstood, be misleading or, in extreme cases, deliberately deceptive. As a distinguished American geographer, Dr. J. K. Wright, has insisted, "Map-makers are human." Apart from error to which all are liable at times, map-makers may approach their work subjectively and, unconsciously or not, convey the impression they wish to impart, rather than that to which objective research would lead them. It is unnecessary to labour this point here; many will recall the neat, simple and at first sight convincing maps which German "geopoliticians" were accustomed to produce before 1939, complete with heavy arrows directed at the heart of their country, and various devices to exaggerate the proportion of "Reichsdeutsch" beyond their boundaries. In a milder fashion, the use of Mercator's projection, with the territories of the British Empire coloured red, was symptomatic of the same approach. At the same time, though such maps are unreliable for their ostensible purpose, they are at least evidence for the state of mind of their compilers. This, however, is diverging from the path of the geographer into that of the politician and historian; but it cannot be too often emphasized that every map can convey something of value to the geographer, provided he thoroughly understands the purpose in the cartographer's mind, and the manner in which he has expressed it.

What may broadly be called topographical (or general) maps are, properly understood, a mine of information to the

geographer. But there is also another rich source at his disposal: this is the class of maps usually known as topical, or special, maps. Their number is legion—in theory they could include any distribution in which a geographer is interested. There is, however, only space here to mention briefly those usually found in a good general atlas. Some atlases include geological maps, but it is now recognized that a more useful picture of the character of a land surface can be conveyed by a structural map. In the first place a geological map records the solid geology, that is, the rocks, generally classified by age, which are fundamental to the physical make-up of a region; they are often, however, covered by recent superficial deposits, e.g. glacial drift, windblown sands, alluvium, volcanic lava, etc., which are often of more importance for human settlement than the rocks at greater depth. The geological classification by age into eras (Quaternary, Tertiary, Mesozoic, Palaeozoic and Pre-Cambrian) and periods is important for geological history, but of lesser concern to the geographer. Thus structural maps emphasize the last process which the rocks have undergone: and indicate, for example, areas of Pleistocene deposits (the most recent), zones of alpine mountain building (with characteristic topographical features indicative of their relatively youthful formation), metamorphic rocks (usually sedimentary rocks modified by great heat or pressure), the older sedimentaries, according to the amount of disturbance they have undergone, and the basement rocks of the ancient shield. In the chapter on physical geography something will be said of the significance of these features and their distribution. From the structural map, a general notion of the character of the surface can be formed.

Maps of annual or seasonal temperatures and precipitation (rainfall and other forms of aqueous deposits) are usually included; the varied combinations of these, taking into account also other factors such as evaporation, humidity, and reliability, contribute to the construction of climatic maps. Some points to be remembered here are that the temperature maps may plot absolute temperatures or temperatures adjusted to sea-level; and that the quantities shown are averages over long periods. Within these, considerable divergences from

average conditions may occur, as the cold spell of early 1963 dramatically demonstrated. It is possible to map the probable limits of these departures as has been done in the *Climatic Atlas of the British Isles*. Finally, a certain subjective element can enter into all schemes of climatic classifications; what, for example, is the relative importance of humidity, evaporation, the persistence of strong winds, or duration of sunshine, in characterizing a climate? Other maps frequently found cover land-use, population distribution, and industrial production. Since these subjects are treated later in this outline, nothing further will be said here, except to emphasize again the necessity of thoroughly understanding what the map purports to show, and to what degree it has been generalized.

An account of geographical techniques, however summary, would not be complete without some reference to other graphical methods of representing and analysing data. Structure and topography can be effectively presented by block diagrams; these are essentially perspective drawings of an area based on the details furnished by the topographical map. By means of sections on the two leading edges they also indicate the underlying structure. Directions for drawing these can be found in good text-books such as A. A. Miller's *Skin of the Earth*. A simpler form is the cross-section, taken from a contoured map, with the vertical heights somewhat, but not excessively, exaggerated. For simple maps giving statistical information, the so-called "pie" method is popular. This consists in dividing a circle into "slices" proportionate to the categories to be shown. For instance, if the figures involved are 50 per cent agricultural land, 25 per cent forest, and 25 per cent industrial and other uses, the circle would be divided into one half (agriculture), one quarter (forest) and one quarter (industry). The diameter of the circle is made proportional to the total area involved. Where the total areas vary considerably over the map, some circles may be inconveniently large; to avoid this, the Swedish geographer Sten de Geer had the ingenious idea of representing the totals by spheres, instead of circles. The most usual method of representing distribution, i.e. number per unit of area, is by line-ruling, making the lines closer together to represent greater

densities, or by the use of tones of increasing intensity. To show seasonal variations of annual rainfall, some cartographers locate small graphs at the relevant stations. This method can show the changes in considerable detail, but does not present the data so that it can readily be compared with other areas. The same general principles apply to the construction and use of these methods as to maps. Their purpose and degree of accuracy must be made clear, and the user must not read more into them than the cartographer intended.

For many geographical purposes, therefore, a map is an effective way of expressing a variety of data, and often there is no other method of showing complicated relationship so clearly.

Technological advances have placed a range of implements in the geographer's hands. The development of photography, both on the ground and in the air, for topographical survey and map-making has been rapid, particularly since the 1939-45 war. Air photographs, taken in the right conditions, are also of value to the geographer who if skilled in their interpretation can learn much from them about the structure, geology, vegetation and human geography of an area, and can correlate conditions in one with those of another which he has studied in the field. Methods of acoustic, or echo, sounding, which are of fundamental importance to the oceanographer, are applied to determining the thickness of ice of a glacier and of ice sheets, and also afford a way of mapping the land surface below them. A photogrammetric survey of a glacier, or indeed of any physical feature, taken at regular intervals, will provide a valuable quantitative record of changes in its form and volume. The drift of material along the coast has also been determined by observing the progress of pebbles treated with radio-active material.

In a laboratory it is possible to recreate the physical geography of an estuary or a portion of the coastline, and to follow, for example, the effects of tidal scour or of sedimentation under controlled conditions. Other examples of the possibilities of new techniques will occur to the reader. The point to be made is that no individual can, or should, be expected to know the theoretical basis of all such techniques; he must endeavour to discover which if any can assist him in

his particular study and master its principles. Through these and similar methods the geographer can give greater precision to his work, and in many instances arrive at quantitative conclusions in place of the sometimes wide, though attractive, generalizations of the past.

CHAPTER SEVEN

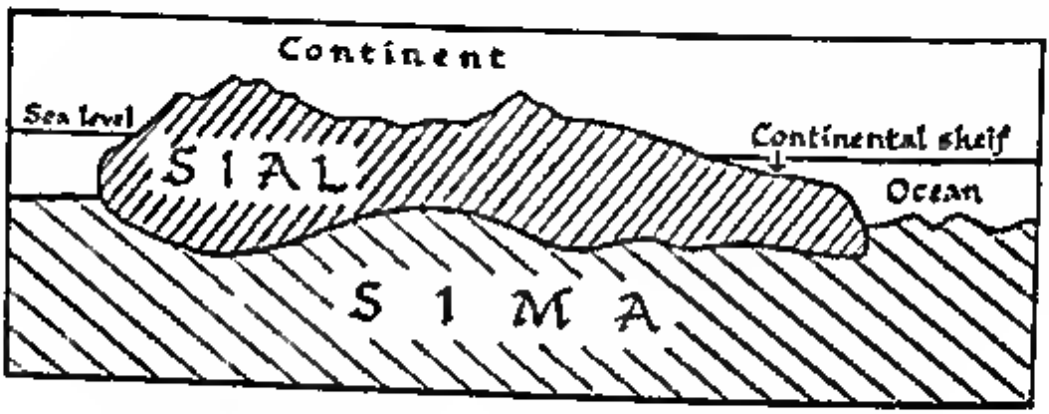
The World Around Us

BEFORE we discuss the processes which are at work on the earth's surface to produce and modify the land-forms we see around us, a brief account of earth-history may help to make them clearer. In the following paragraphs I have avoided as far as possible the intricacies of the geological time scale and the technical terms for the eras and periods. To place these in perspective the following brief statement may be helpful. The oldest rocks (Pre-Cambrian) are dated at approximately 2-3000 million years ago, the carboniferous (coal-bearing measures) at 200 million years; the Cretaceous period (which includes the Chalk) at around 100 million years; the Eocene (including London Clay) at 45 million years. Against these figures it may be noted that the earliest fossils, representing primitive forms of life, date from 500 million years, and that the earliest men appeared within the last two million years. In other words if the oldest rocks had been laid down a century ago man would have been on the earth for approximately two months.

The present features of the earth's surface are the product of long periods of geological time. Opinions differ as to the permanence of the oceans and continents. Supporters of the hypothesis of "continental drift" argue that the present continents are portions of one very ancient land mass which have drifted from the original position in the southern hemisphere. Much of the evidence they advance is impressive but there are many objections to be removed. A basic difficulty is the source of the energy required for such a dispersal. Nor is it easy to reconcile the theory with facts such as the apparent permanence of the basin of the Pacific Ocean in geological history. This is a problem for the geophysicists; geographers are interested in so far as the history contributes to an understanding of the present structure and its relationship to exist-

ing features of the relief. The main structural elements of the continents can be stated simply, provided that it is realized that the details are complex and in many instances disputed.

The continents are regarded as blocks of lighter material (*sial*) floating in a denser component of the earth's crust (*sima*). The general level of the blocks adjusts itself according to the load they are carrying; for example, prolonged erosion of sedimentary deposits thousands of feet thick would cause elevation, and the accumulation of a great ice-sheet would



1. Generalized sketch of continental structure.

bring about depression, in relation to the level of the sea. At intervals in geological time, following a relative rise in sea-level, considerable areas have been invaded by the sea (transgressions), in which newer sediments have been laid down over the older rock formations. These movements, combined with convectional currents in the substratum, set up great stresses in the *sial*. Strata laid down more or less horizontally on a sea bed, may be forced by compression into great folds: these are known as anticlines if arched, and as synclines if they are depressed. Tension may also produce faulting of the strata, in which there may be considerable displacement vertically or horizontally. A rift valley, e.g. the great East African rift, is a depression lying between two approximately parallel faults.

Two major structural forms in particular can be differentiated. The continents appear to have grown around certain rigid masses of ancient rocks which have been stable over great periods of time. Characteristic examples in Eurasia are the Fenno-Scandian "shield," the central Asian complex, and

3. The world: some important structural features.

the southern Indian table. Elsewhere there are the Canadian shield in north-eastern North America, and the plateau of western Australia. Most of Africa can also be regarded as one ancient rigid block. In contrast to these are the "young" mountain systems. Four great periods of mountain-building are recognized of which the Alpine system is the youngest. To this latter group belong the high, folded mountains of the world. In Eurasia the Alpine system extends from the Cordillera of Southern Spain through the Pyrenees and Alps, the Balkans, Caucasus and Himalaya to the East Indies. The second great Alpine system comprises the ranges which surround the Pacific Ocean, from the Andes through the Rocky Mountains, the Kurile and Aleutian Islands to the island arcs of Eastern Asia, where it meets the Alpine-Himalayan system. The mountain systems originated in sedimentary strata deposited in geosynclines—that is, long narrow troughs in the ocean beds. These troughs, in contrast to the shields, are unstable areas of the crust. For reasons arising from geophysics, these strata were then forced upwards and outwards in folds, and elevated to great heights. In a general way, these geosynclines were marginal to the rigid "shields," and in some degree the young folded mountains are the result of pressure from these blocks. The rocks involved in these complex movements have often undergone changes through metamorphism, i.e., alteration through heat and pressure; and magma (molten rock) has been intruded from below, for example, by volcanic action. The association of active volcanoes, Alpine folding, earthquake foci, and ocean deeps is not accidental.

Distinguishable from these shields and young mountain ranges, there are two other forms; relics of pre-Alpine periods of mountain-building, much worn-down and affected by later earth-movements; and great expanses of sedimentary rocks of various ages and subject to varying degrees of disturbance and alteration, including metamorphism. Finally there are the latest deposits including the alluvial deposits of rivers and lakes, the gravels of river terraces, the clays, sands, and coarser rock material transported and deposited by former ice-sheets and glaciers and the sand-dunes resulting from wind and mechanical erosion (see page 99). These latest deposits mask the regional "solid" geology.

The interest of the geographer in these processes and products is centered largely in the character of the surface features they produce. Though they have already undergone much erosion, the Alpine-fold mountains retain "youthful" features —sharp serrated crest-lines and summits, with high passes; deeply incised valleys and precipitous slopes, with snowfields and glaciers often at higher levels. The lower slopes have a sparse vegetation which gives way to forest lower down. The rigid shields, of considerably lower elevation and generally worn down by erosion over the ages, are much less accidented, having rounded, rolling contours, and, where heavily glaciated, many lakes. The rocks of these shields are important economically, as they are main sources of metalliferous ores —gold, platinum, copper, etc. Each type has its own characteristic soils, sparse and undeveloped on the mountain sides, somewhat less impoverished on the shields. It is on the less disturbed sedimentary rocks ringing the older rigid masses that deeper soils tend to develop. The workable coal measures are associated with moderately folded sedimentaries. As will be seen later, the type of soil depends considerably on regional climate and local conditions.

In a general view, the mountain systems are important to man in so far as they inhibit or hamper his movements over the earth's surface, but their significance lies in their role in relation to the great movements in the atmosphere which influence climate and, consequently, soils and vegetation— in short the environments in which men pursue their varied activities, and which extend far beyond the lower slopes or foothills.

Before examining the content of physical geography in some detail we may usefully apply some of the themes outlined above to the British Isles. Most travellers will have noted the great variety of their scenery, and the clearly distinguishable regions. There is in fact more to interest the geologist and the physical geographer in these islands than in any other area of comparable size. The geological history of these islands, as with other land masses, illustrates certain general processes: changes in elevation in relation to sea-level; the effects of gigantic crustal disturbances, sometimes referred to as "storms," periodical invasions of earlier land-surfaces, which

have been depressed, by the sea (transgressions), erosion of land-surfaces; deposition of beds of sediments in some instances many thousands of feet thick, which originate in the material eroded from the lands; the elevation of these beds above sea-level, at which point the process of erosion and deposition starts up again. The geology and physical relief, as we know them today embody this history, which has been traced out from the remnants of these sedimentary covers, their distribution, position and age.

As can be seen from a geological or topographical map, the main structural contrasts are between Highland Britain in the north-west and north, and Lowland Britain in the south-east, approximately separated by a line running from Lyme Regis to the Tees estuary. In the Highland section, the "grain" of the country runs from south-west to north-east, the scenery of Donegal resembling that of the Highlands of Scotland. The rocks, of greater age than those in the south, have been subjected to much movement, faulting and injections of plutonic material, the main mountain-building movement (Caledonian) being much older than the Alpine period mentioned above The Central Lowlands of Scotland may be regarded as a great rift valley filled with older, undulating sedimentary rocks. The highland type of scenery is in general repeated in the Lake District and the Welsh mountains. Having been subjected to heavy glaciation, the contours of the mountains have been smoothed and rounded, the U-shaped valleys with their fast running streams, lochs and tarns are scattered with boulders and deposits of glacial origin. The mountain sides are bare and boulder strewn; owing to this geological history, areas of good, well-drained soils are not extensive but on more favourably placed deposits there are fertile patches. Dartmoor and Exmoor, in the south-western peninsula, represent the much altered remnant of a mountain-building period intermediary between the Caledonian and the Alpine.

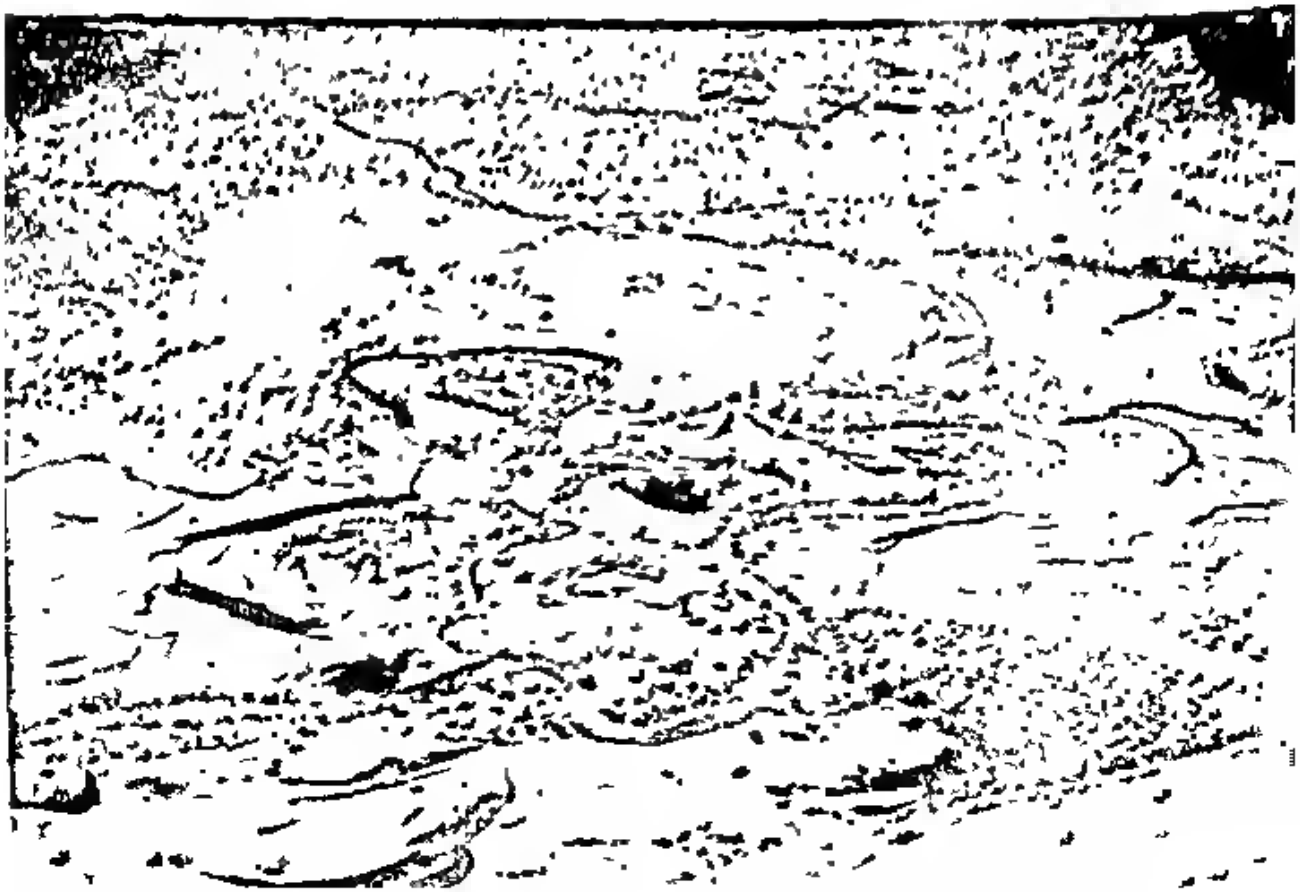
South of the line, the general grain of the country remains south-west to north-east in the north, reflecting generally the Caledonian movement, but in the south-east the Alpine movement has produced east-west folding.

It is not necessary for our present purpose to trace the

1 The Grand Canyon of the Colorado river, Arizona. The river has cut its bed through horizontal strata of varying hardness

2 Qizil Uzun valley, Persia: valley erosion and gullying in an arid climate.

3 The Murray river, near Albury, New South Wales. The remnants of former meander-loops are conspicuous



4 The Mattaghorn glacier, Switzerland the stream flowing in the valley formerly occupied by the glacier.

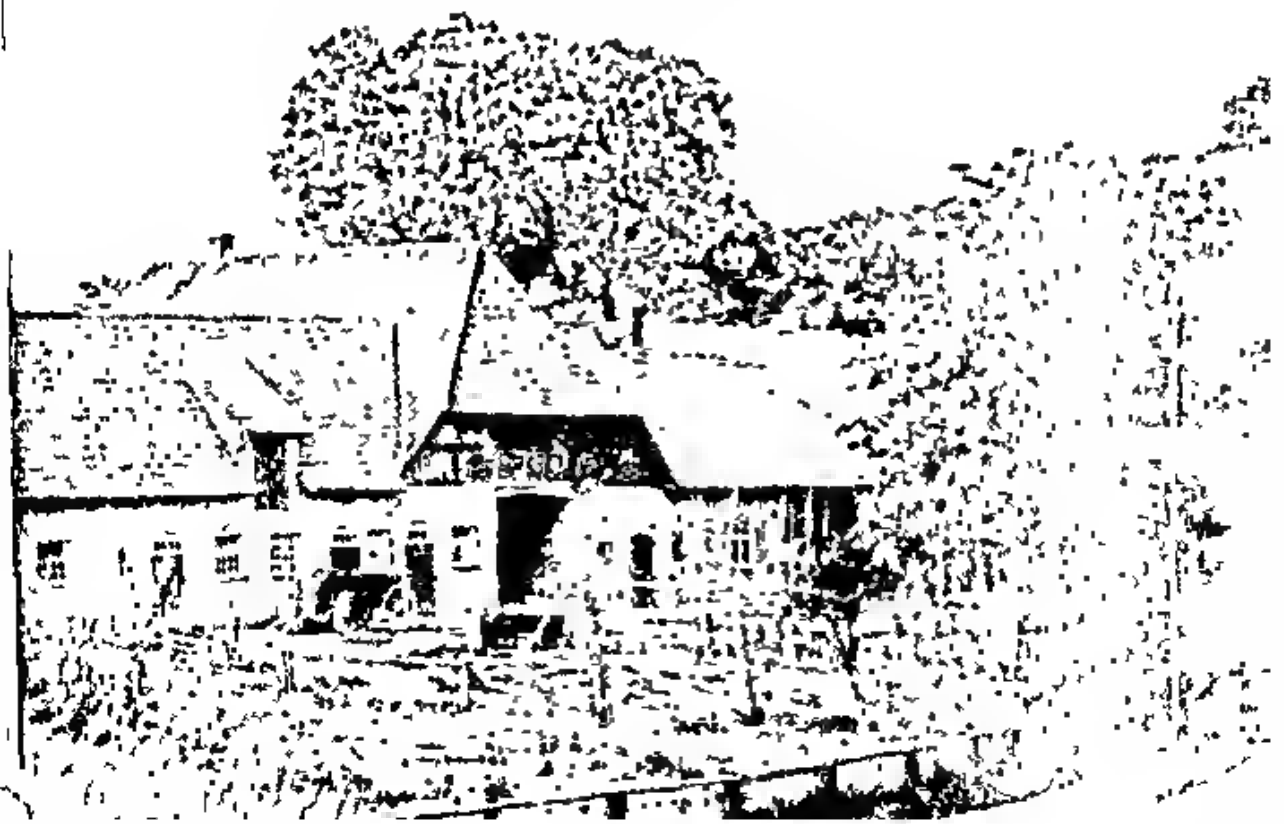
5 Himalayan foothills and main range from Darjeeling

6 Coast of Enderby Land, Antarctica: pack-ice, tabular bergs and inland ice-sheet.

7 The coast of Graham Land, Antarctica, edge of plateau (6,000 ft above sea-level), glaciers and coastal mountains

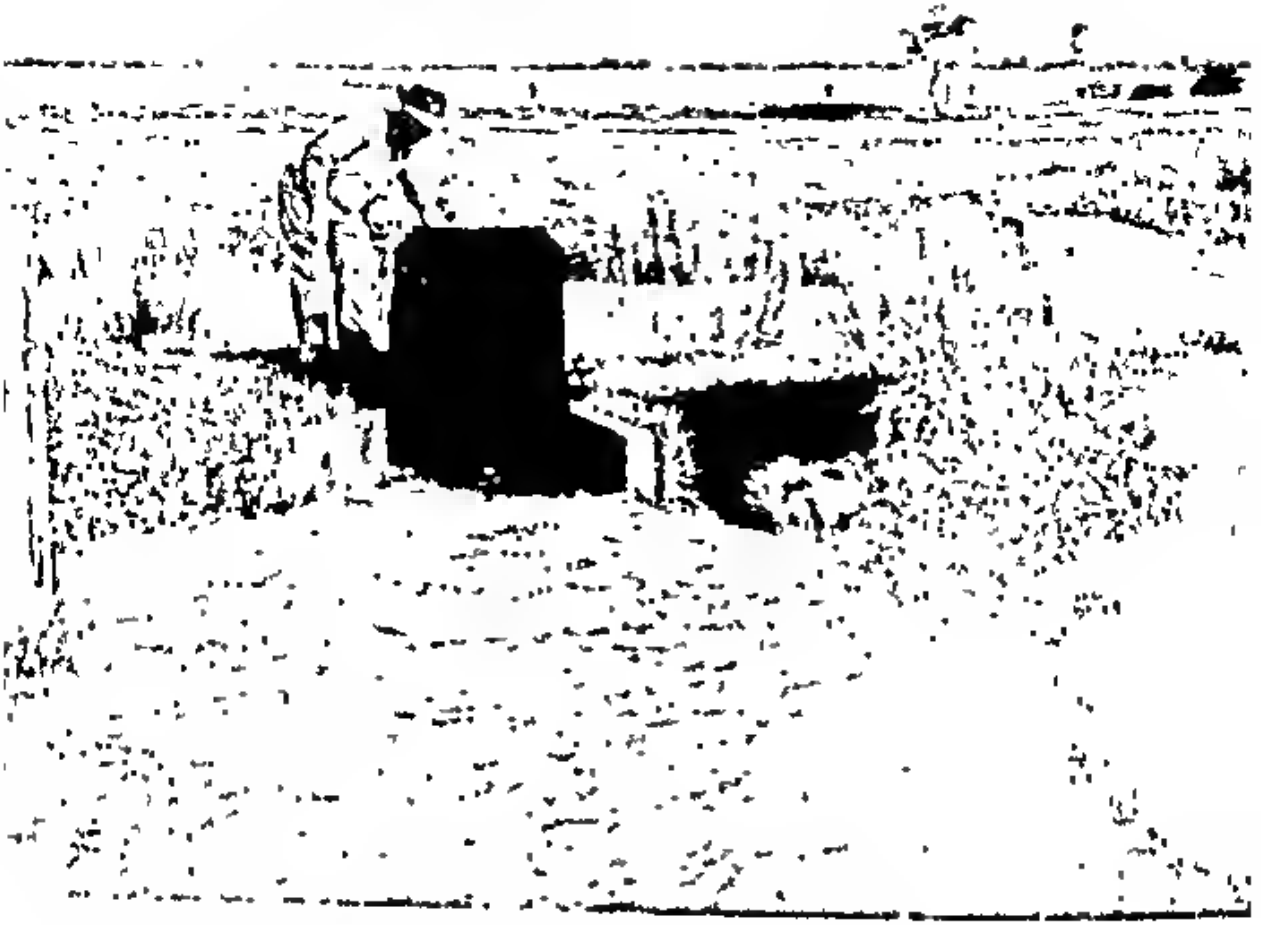
14 Farm near Hilltown, Co Down, small fields on lower slopes of the Mourne Mountains

15 Farm buildings, lower Saxony : animal stalls on left, dwelling on right, large hay-loft.



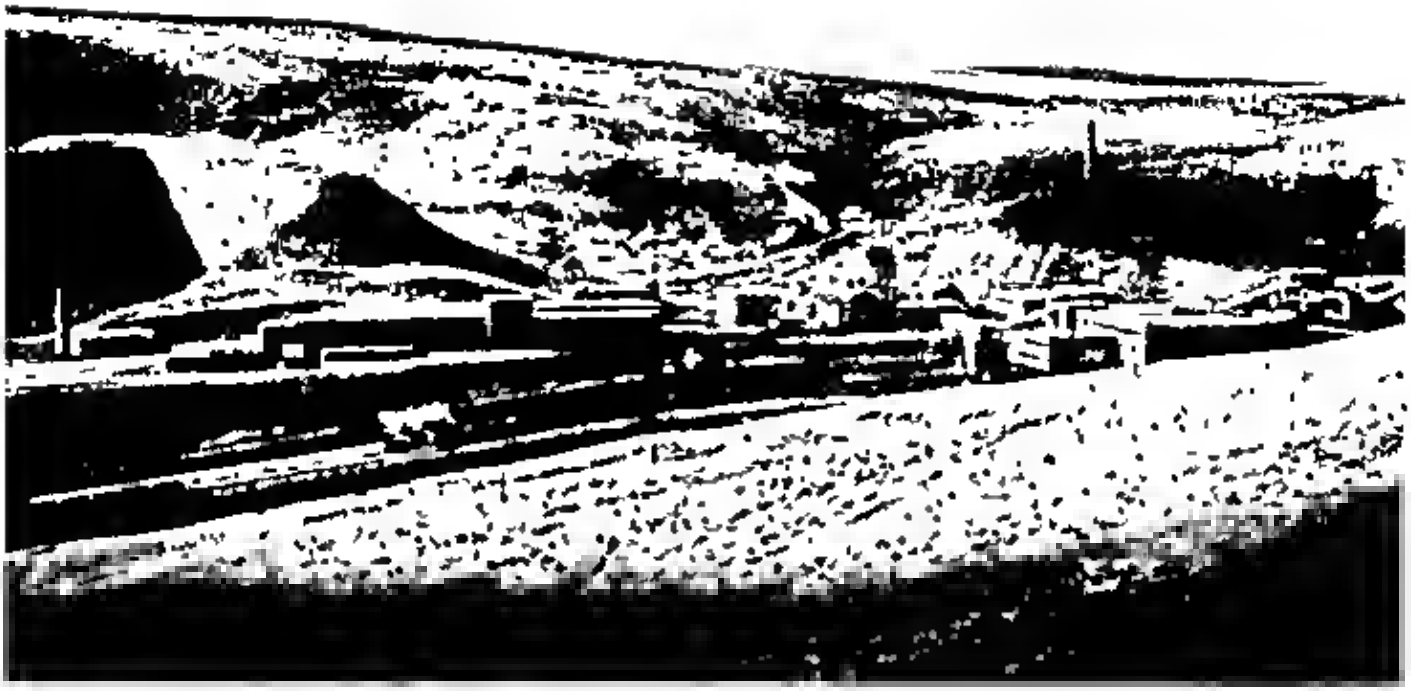
16 Shifting cultivation, Ghana: second-season maize among tree-stumps.

17 Malloca (communal dwelling) in clearing in tropical rain forest, near Rio Parima, Brazil.



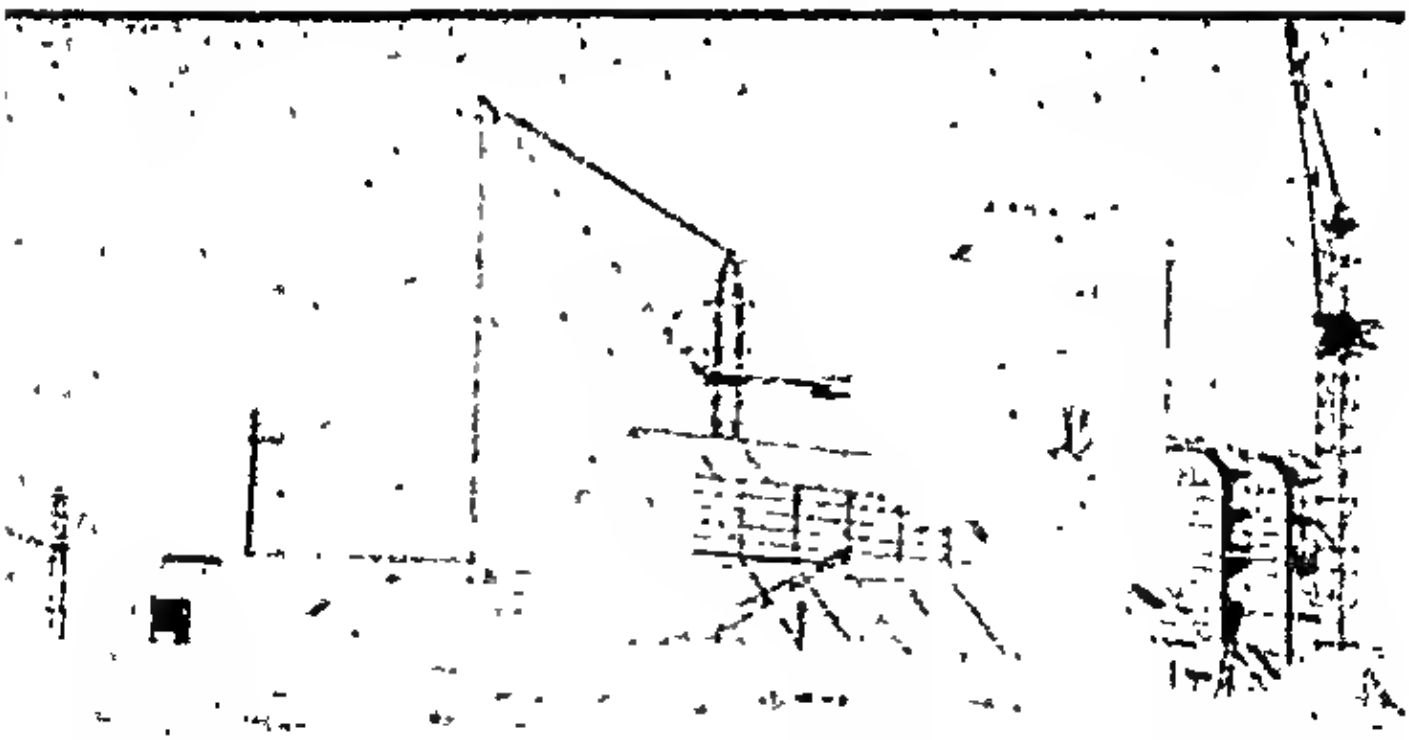
18 Murrumbidgee irrigation area, New South Wales · irrigated rice fields

19 Mustering merino sheep for shearing, Benangaroo, Southern New South Wales · dark patches on river flats are irrigated plots of lucerne



20 Mardy colliery, Glamorgan recently reconstructed surface buildings, spoil heap on left.

21 Blast furnace, Bhilai, Madhya Pradesh.



22 Iron ore mining, Caland Mine, Toronto, with development of water-power resources

23 Modern Antarctic base, McMurdo Sound, nuclear reactor in hill-side

geological history back to earliest times; we may begin with the Mesozoic era (which includes the New Red Sandstones, the Jurassic limestones and the Cretaceous chalk). During this era most of Britain was covered by a great blanket of these rocks, which resulted from an earlier transgression, and had been flexed by earth-movements. Much of this blanket was then stripped off by erosion. (The dividing line mentioned above runs close to the margin of the exposed Mesozoic strata.) The rate of erosion was intensified when the general tilt became easterly. The residue of this Mesozoic cover is now in part represented by the Chalk of the North and South Downs and the Chiltern Hills, and by the Jurassic rocks of the Cotswolds and Northamptonshire heights. While these were being eroded, younger sedimentaries, following minor transgressions of the sea, were being deposited in the east between the folds. These include the clays of the London basin and the sands, clays and gravels of the Hampshire basin.

The same pattern is repeated towards the north-west, the exposed rocks become successively older, and escarpments similar to those of the North and South Downs have developed, the most conspicuous being that which extends from the Cotswolds to Lincoln Edge. On the further side of the dividing line, the structure becomes more complicated partly owing to the longer history of mountain building. A compressed summary here would produce misleading generalizations; we may note in passing the importance of the Pennine area, signified by the great outcrop of Carboniferous rocks. In the south, these have been stripped from the crest of a broad arch, exposing the Millstone grit, but on each flank the youngest carboniferous rocks have been preserved. These are the coal measures, partly covered by younger strata, which account for the disposition of the Cheshire, Central Midlands and East Midland coalfields.

The final major factor in the formation of the landscape was the Ice Age. Glaciation did not affect the whole of southern Britain as the ice did not pass south of the Thames and Bristol Channel. Its main result was a spread of boulder clay, sands and gravels, which has influenced the siting of human settlement and the distribution of arable cultivation.

The scenery of the lowlands is therefore much gentler, partly

because of the less resistant nature of the rocks. The highest elevations do not exceed 1000 feet, and the prominent scarps are of the order of 500 feet. It is a land of moderate hills, gently undulating plains and meandering rivers. The scenery varies with the character of the rocks and associated soils, from the rolling, turf-covered Downs with their dry valleys and clumps of beech, the thickly wooded clays of the Weald, and the hedgerows and pastures of the Shires, to the flat, intensively cultivated expanses of the Fenland, one of the most recent additions to the agricultural resources of Britain. Set down among these scenes are the villages, towns and the great centres of population, London, the Midlands and the North, each integrated with its geographical environment. How these have grown up is the subject of a later chapter.

We have glanced at major forces and processes which have shaped the principal features of surface relief. The detailed land-forms which we can examine today are the result of various erosive agents which are continually at work to modify and shape the relief. Rain, running water, frost, heat and wind are among the more important of these; consequently the atmosphere immediately above the earth's surface comes within the purview of the physical geographer. Though space does not permit any detailed treatment here, it must not be overlooked that the oceans also play an important part; if only in one respect—through coastal erosion and deposition—the sea makes its contribution to geomorphology (the study of land-forms). All these agents are active within a relatively narrow band (sometimes referred to as "the skin of the earth" or "envelope"), comprising the sub-crustal strata, the surface and the atmosphere. Within this lies the work of the physical geographer.

The study of land-forms is founded upon principles firmly established in the early years of the nineteenth century. The ruling principle is that of uniformity. Over the whole surface of the earth, similar conditions set in motion similar processes, and these processes produce similar results. Where apparent variations take place, these are to be explained by differences in the ruling conditions. Not only does this uniformity apply to the present, but it also furnishes a key to the past. This is

supported by two geological precepts: the younger, i.e. more recent, bed lies above the older (except in very special cases); and groups of similar fossils will occur in beds of the same age. From these it has been possible to produce a geological chronology. The principle of uniformity was first clearly enunciated in Britain by Sir Charles Lyell, as the title of his great work testifies—*Principles of Geology; being an attempt to explain the former changes of the earth's surface by reference to causes now in operation*, 1830. It is easy to see now that for example, the silting-up of the port of Sandwich several centuries ago can be explained by what is to be observed today; it was not so easy for early workers to realize that the same conditions which can be observed in a small stream dawdling across the English plain could produce for instance the meanders of the river Wye at Simmonds Yat and, at the other end of the scale, the Grand Canyon in western America. The processes which produce land-forms can be seen at work every day, in the constant beating of the sea on the beaches and on the cliffs, in the undercutting of their banks by rivers, and in the gullying of slopes after heavy rainstorms, to mention more obvious examples. The prolonged action of frost, also, gradually reduces great granite boulders to fragments. In most settled countries, the effects of these are controlled by man-made works, the groynes and cliff-walls along our coasts, the training wall and embankments along the rivers, even the drains down the slopes of railway cuttings. Despite these precautions, these processes continue, and, unless vigilance is maintained, will eventually overcome these restraints. But in addition to these, there are less obvious and much longer-term changes in progress. A continuous fall in the underground water table will be revealed in changes in surface drainage and in a lowering of the water level in wells. The steady creep of soil downhill may result in a decline in the fertility of an agricultural district.

Alongside these steady, undramatic changes are to be set the spectacular, often catastrophic, displays of natural energy such as earthquakes and volcanic outbursts. Added to these are the long-term secular changes scarcely detectable but of potential importance in the long run, such as changes in the level of the sea relative to the land or long-term climatic

fluctuations. It has been shown for instance that in south-east England the vertical downward movement is about 3 millimetres per year, while north-west Scotland is rising at a slightly faster rate (4·5 millimetres per year). A similar but more significant movement is taking place in Scandinavia. Though scarcely perceptible by any one generation, their cumulative effect could be serious, and such trends, if established, cannot be altogether neglected, for instance, by those concerned with the protection of the Netherlands from the sea and the reclamation of new land for settlement. It has, for example, been established that the Arctic seas are slowly but definitely "warming up."[1] An increase and continuance of this trend must result in a melting of the ice-cap in Greenland and elsewhere, with a corresponding increase in the volume of sea water, and a consequential rise in the sea-level. A sinking coast-line plus a rising sea-level might thus reinforce each other. It is not only long-term trends that can coincide in this way. The storm which in 1953 wrought such havoc in the lands bordering on the North Sea is a case in point. The destructive surge was due to three factors coinciding: (i) high spring tides (ii) the swollen state of the rivers caused by recent heavy rain (iii) strong winds from the north-west to north-east, which carried the tidal flow up the estuaries and at the same time held up the flood-water coming down stream. The combined effect was to raise the flood-level several feet above the normal, and to burst the defences against the sea, with heavy loss to lives and material.

There are thus two main forces working on the land surface; external and internal. The external forces are atmospheric precipitation, providing the agent (running water) which in time transports much of the products of erosion to the sea; the wind which can move smaller, lighter particles about to form new land features, e.g. sand dunes, or, by driving these particles against exposed rock, erode it away; rapid changes in temperature which by alternatively heating and cooling rock will fragment it, and frost which by freezing water percolating into cracks in the rock will split it apart. These are physical agents, but there are also chemical agents at work less obtrusively, e.g. the carbon dioxide dis-

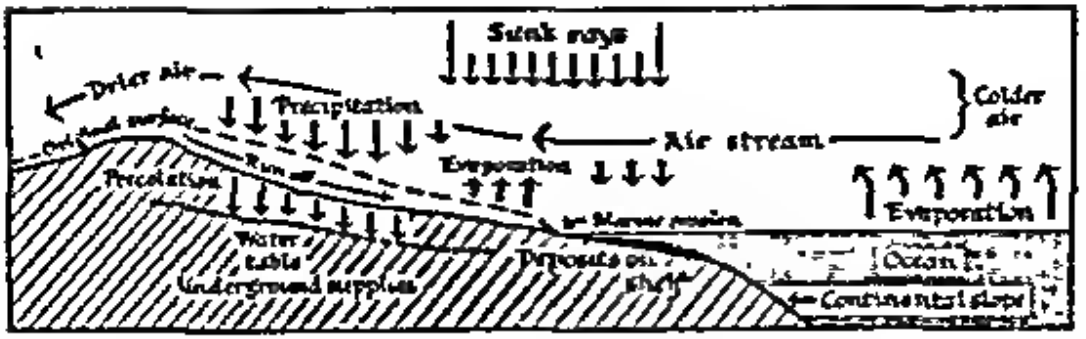
[1] This trend now appears to have been checked.

solved in rain water will react on carboniferous rocks and dissolve them, and clefts in rock can be enlarged by the chemical action of sea-water. The internal forces at work are more complex; sub-crustal disturbances will cause differential movements of the land, resulting, where the stress becomes acute, in earthquake shocks, large-scale faulting, and volcanic outpourings.

To these elements in the fashioning of the landscape a third must be added, the character and structure of the rocks upon which these elements operate. This is the point at which the geologist is most closely associated with the geographer. Clearly the extent and severity of erosion will depend upon the physical and chemical composition of the individual rocks; those with little cohesion—sands, gravels and certain sedimentary rocks—offer less resistance to mechanical erosion; others are soluble in water, allowing water to percolate through them (limestones); others again are impervious and will hold water in the pervious beds above them.

These erosive forces are continually at work. There is another which, while still potent in certain regions has left its mark on much wider areas. This is the action of ice and snow. Their effects, which can be studied today in the Alps and the ice sheets of Greenland and Antarctica, are striking, often spectacular; the high field of snow and ice forming the source of the glacier; the "river of ice" slowly descending its characteristic U-shaped valley with its tributary glaciers, the marginal and medial bands of debris (moraines) formed by rock fragments falling from the valley sides or plucked and scoured by the ice from its bed, the terminal moraines, marking stages in its advance and retreat, the swift icy stream issuing from the glacier snout and often rushing in rapids or waterfalls over "steps" indicating halts in the glacier's history —all these will be familiar to visitors to Switzerland. Formerly great areas, owing to the prevalence of more severe climatic conditions, were covered by great ice sheets, perhaps thousands of feet thick. Another change in climate, probably not very considerable, removed this cap, and many of these glacial features can be observed in areas now free from the ice, e.g. the Highlands of Scotland or the lake region of Finland. At one time, controversy raged as to whether glaciers excavated their valleys,

but it is now thought that to a considerable extent they modified the earlier topography by deepening valleys and rounding off or polishing the contours of the land. An instructive example of the application of the principle of uniformity is to be found in the history of glaciation studies in Britain. It was by proceeding by analogy from the study of existing glaciers in the Alps, with their associated moraines, boulder clays, striated rock surfaces, *roches moutonnées* (boulders shaped by ice), and their characteristic U-shaped valleys and steps, that British scientists unfolded the history of the Ice Age in Britain. Speaking very broadly, they studied the landscape of Switzerland where glaciers could be seen at work, and then returned to Britain, to put the ice, as it were, back into the landscape in such a way as to account for the relict landforms which they mapped out on countless excursions in the field. They were able to go even further than this. By careful study of the distribution and age of the Alpine glacial features, it has been possible to establish a series of stages representing variations in the extent of the ice-cover. Working on these lines, British scientists eventually established similar fluctuations in the extent of the ice, and correlated them with the Alpine stages. Thus working outwards from one relatively small area, it has been possible to reconstruct Ice Age conditions not only over Europe but over extensive areas of the world. The study, however, did not end here. Obviously the fact that a much greater area was at one time under glacial conditions did not affect this area alone, but must have had much more widespread consequence in, for example, climatic conditions. Added to these factors of the atmosphere and the earth's surface, there is a third to be considered, namely the ocean which is the source of the water deposited on the land. These three are linked together in what is known as the "hydrological cycle." The moisture, evaporated from the surface of the sea through the sun's heat, is carried over the land by the movements of the great air masses and deposited mainly as rain on the land; it then contributes to the erosion of the surface and eventually, in temperate regions much of it finds its way back through the rivers to the sea, where the process begins again. This is of course a simplified scheme. In practice it will be modified in various



4. Diagram to illustrate the principle of the hydrological cycle.

ways; the wind systems will not blow constantly on shore, for instance; much moisture is lost by evaporation from the land surface, so that in zones of great heat the rainfall does not balance this loss; some may not find its way back to the sea directly, particularly if it falls as snow at high altitudes. Nevertheless the "hydrological cycle" gives a useful generalized picture of what is happening.

This conception of a cycle appears again in theories of the evolution of landforms. Perhaps the best known is the so-called "cycle of normal erosion," a hypothesis first put forward by the American geographer, W. M. Davis (1850-1934). This is an attempt to explain what is happening to the earth's surface under the erosive forces described above The general conception is that of an emergent land-surface being worn down by agents of erosion to base-level, when, on elevation of the surface again, the whole process re-commences. The term "cycle" is not accurately used in this sense, since such a series of events occurs over a great span of time, and no actual case can be cited of one working itself out and re-commencing—an occurrence which would be necessary to justify the use of the term "cycle" in its strict sense. Nevertheless this hypothesis serves to give a coherent explanation of certain erosion features and land forms which are observable in the field. It also introduces the useful concept of process-structure-stage: for example, the present pattern and characteristics of a river system may be explained by: (1) process, e.g. rapid headward erosion; (2) structure, e g. having cut down through a resistant strata, the rate of erosion is increasing as the headwaters are working across a less resistant strata; and (3) stage—in this instance, since the river is still vigorously

eroding, its profile is relatively steep, or ungraded; hence it is at a youthful stage. The cumulative effects of erosion are held to result in the gradual reduction of all features to a general level (this process is known as peneplanation), eventually at or near base-level, that is, approximately, contemporary sea-level. The successive stages are described by terms "youth," "maturity," and "old age." An ideal mature river would be one with a fully graded course, i.e. with a steady, but small fall, its course unobstructed by waterfalls or rapids, meandering slowly across a wide featureless plain, with a tendency for banks to form in its course and perhaps terminating in a delta, according to condition at its mouth.

The above outline is considerably generalized and the picture is complicated by crustal movements, geological factors (including texture of rock) and over long periods even by changes in climate. While the Davis hypothesis has been favourably received for a number of years, and has provided a fruitful approach to the study of land-forms, the attitude to it has recently become more critical. It has been criticized for attaching too much importance to the role of rivers in deepening and widening their valleys. The rival school of geomorphology maintains that erosion is taking place horizontally, i.e. that slopes are being worn back, rather than that erosion is vertical, that is downwards. In this connection they visualize the edges of resistant beds as being in parallel retreat. One agent in this process would be large scale flooding causing extensive sheet erosion, rather than a river down-cutting its bed. The Davisian theory is also held to attach too little importance to geological structure, and to neglect the role of earth movements.

No final conclusion has yet been reached. Though the "cycle of normal erosion" admittedly does not explain all land-forms, it interprets river patterns and their developments intelligibly; Davis's great service, however, was to introduce the concept of historical evolution into land-form studies and to open a fruitful field for further research.

In the discussion of erosion and land-forms, the important part played by climate in their formation has been emphasized. But this is not the only aspect which interests the geographers. Weather and climate, particularly the latter, are of

great significance in e.g. the formation of soils, and the types and distribution of vegetation and animal life, and in many of the conditions in which men live and work. "Weather" is the term applied to the daily or short-term features of the atmosphere; climate is the average weather conditions over considerable periods of time. Though geographers are interested in weather conditions—snow, lying on 20-30 days a year, interrupts communications across the Pennines each year and sudden storms at harvest time may be disastrous for farmers—it is climate which is the geographer's main concern. For individual regions, the components of climate—atmosphere, pressure, winds, temperatures, precipitation—occur in a great number of combinations, which can vary not only from season to season but from year to year. The principal combinations, however, occur in clearly distinguishable climatic zones over the surface of the globe, the main determinant being position in relation to the Equator and to the dominant air systems and ocean currents, reflected in the amount and seasonal distribution of temperature and rainfall. Compare for example the relatively favourable climate of the British Isles—lying to the windward of the Eurasian continent and the harsher climate of Newfoundland, on the lee side of North America. Another modifying influence is the character and altitude of the land surface; winds deflected upwards into cooler layers of the atmosphere by mountain ranges deposit their moisture on the windward side; descending on the lee side, they are drier and produce an area of "rain shadow." (The Alpine *foehn* is a wind of this type.) A striking example of this is seen in the contrast between the mild, wet climate of British Columbia and the more extreme, drier climate of Alberta. Another effect of position and altitude is seen in the contrast between the Indo-Gangetic plain and the high, cold Tibetan plateau beyond the Himalaya. Within these great climatic zones, there are of course minor variations of topography which are reflected in local climates: some reference to these is made below in considering microclimatology.

Springing from these considerations are factors such as accumulated temperatures (excess of temperatures above a given minimum) duration of daylight and duration of snow cover; in combination these express themselves in important

considerations for farmers such as length of growing periods. It is not possible to go into greater detail here: even a cursory study of the relevant maps will suggest many other examples. But what is important is to realize that quantity (of precipitation, etc.) is not the sole consideration; quality is of almost equal significance. A total annual average rainfall of twenty-five inches can mean several things to farmers. First, how reliable is it? If it signifies thirty inches in one year and twenty inches another, it can obviously present them with difficult problems in regard to stock and crops. Again, how effective is the rainfall? In certain areas, evaporation can offset a considerable rainfall, though its effects can be minimized by conservation measures and specialized methods of cultivation. Then there is distribution over the year; heavy downpours or cloudbursts, with the consequent gullying, sheet-erosion, and rapid run-off are of little or no benefit. Sufficient rainfall at the right seasons is the dream of the arable farmer in western Europe. There, wheat is the grain most dependent upon climate and soil. The best quality is grown in areas with (i) a moderate rainfall of 15 to 35 inches a year, received earlier rather than later in the growing season, (ii) a warm summer and autumn (three months with average temperatures over 60°F.) to ripen the grain and allow it to be harvested, and (iii) well drained heavy loams or lighter clays. Within the main zones, climatic régimes can vary considerably over relatively short distances in response to local topographic features, differences in altitude, exposure or shelter from the dominant winds or to the sun; distance from the sea, etc. But even within these local climates, conditions, for example, for the growth of plants can show appreciable variety in a matter almost of yards. Slight changes in soils and drainage also make their contribution. The study of these is known as microclimatology (literally study of small climates). The gardener, consciously or not, is practising this science when selecting sites for particular plants, e.g. by choosing a well-drained bed with a southerly aspect protected by trees, walls or hedges from exposure to winds or the down-flow of cold air. For these, and other physical reasons, conditions at surface-level differ from those occurring even at four feet above the surface. These factors combined with often small differences in soil, water

content, aspect, exposure, and the type of vegetation, create the microclimates in which particular plants or crops will flourish. Climate is thus of importance in relation to the requirements of plant life, in the way of temperature and precipitation and in the distribution of these elements throughout the year. But it has a further influence through its share in the formation of soils. Here it is linked with the study of surface erosion.

Soil science is a complex and rapidly growing subject; but there are certain considerations which can usefully be emphasized here. Soil is the surface cover primarily produced by the weathering agencies and the local vegetation, and is therefore largely determined by climate. The character of the various types is further controlled by the constituents of the parent rocks, the processes which they have undergone, the living organisms within them (e.g. bacteria and fauna ranging in size up to small invertebrate animals and small mammals) and finally by the vegetation itself, which supplies the humus content. The distribution of the great world groups therefore corresponds closely to the climatic regions. Some idea of the character and development of two of these groups can be obtained by glancing briefly at those predominant in the British Isles. Brown forest soils, occurring mainly in southern areas, have a relatively high concentration of basic salts, are rich in nitrogen and have a mild humus content. They are developed mainly on clays and on some sandstones and limestones in warmer and drier areas, humus being derived from leaf-fall. The "natural" vegetation is deciduous woodland. When this is cleared, and the land ploughed and manured, agricultural land of high value is obtained. The second group, known as *podsols* can be derived from almost any parent rock in a cool wet climate. Owing to the higher rainfall, they undergo heavy leaching and thus loss of mineral content, while with the lower temperatures the plant debris does not readily disintegrate, so that the humus tends to be acid. The percolating water carries down the plant nutrients and soluble salts to a lower layer, where a hard "iron pan" may form. This prevents root-penetration and impedes drainage still further. The associated vegetation is therefore poor and stunted, and large areas are in heath. To bring these soils

into cultivation, or to afforest them, this "pan" must be broken up, a difficult and expensive undertaking.

The glacial history of an area has a marked influence on the types of soils. In upland regions formerly heavily glaciated the ice has stripped the surface of soil cover, and left conditions in which only thin undeveloped soils can re-form. In flatter areas ice, when melting and retreating, has deposited the material which it had scooped up and carried along in its advance. These deposits vary in form and constituents. The finer material, where it is well-drained, often forms fertile, arable soils, such as the glacial till over much of East Anglia.

Where the movement of the water in the soil is generally downwards, that is, where total rainfall exceeds loss by evaporation, the podsol type of soil is formed. In the tropics, where evaporation exceeds rainfall, the movement is reversed, that is, the water raises to the surface bringing with it the dissolved salts. Thus the soils are saline, supporting a restricted vegetation, and salt-pans may form. A type of tropical soil, laterite, is discussed in Chapter 12.

From these brief considerations, it will be seen that the soil cover is not an inert mass of more or less fragmented or powdered rock. Within it physical processes are continually active, and it has a biology of its own. If man, by drainage, cultivation, the replacement of mineral and organic constituents which have been removed by crops, and the practice of a balanced agriculture can improve and maintain good soils, he can conversely, by exhaustion of the plant food, neglect, and the destruction of the natural balance, reduce or destroy the value of good soils.

The general pattern of vegetation corresponds closely with that of the climatic zones, local variations being related to the sub-surface or rock mantle, topography and drainage, and aspect, especially in regard to insolation and exposure. Vegetation types range therefore from the evergreen forest of equatorial regions, associated with heat, high rainfall and poorer soils, to the tundra of the polar regions with permanently or semi-permanently frozen soils, a prolonged period of snow cover, and very short, but often warm, growing periods. Intermediate are the great desert areas, particularly in northern Africa and south-west Asia, and the grasslands

and woodlands. The determinant factor in the case of the deserts is low, irregular and variable rainfall, and great range of daily temperature, resulting in lack of moisture and ill-developed soils. The distinction between forest and grassland again is largely due to available effective rainfall and accumulated annual temperature. It must be emphasized that over great areas the "natural" vegetation has disappeared, largely through the activities of man. Much of the woodland of western and central Europe, at least on the lowlands, has been cleared and drained for agriculture and new species of plants and trees have been introduced. On the Great Plains of western America (the "dust-bowl"), by ploughing up the natural cover for wheat cultivation, large areas were exposed to rapid soil-erosion and winds removed hundreds of thousands of tons of the top soil. This is an example, but only one of many, of the results of interference with the natural balance. But if man can destroy this balance, he can also do much to restore it. In the "dust-bowl" area, for example, stability has been restored by contour ploughing (to check rapid run-off and gullying), the planting of shelter-belts to check wind erosion, and the establishment of a suitable rotation of crops to avoid exhaustion of the soil.

Broadly speaking, recent progress in the studies outlined above has been directed towards the increasing adjustment of man's demands on the land to the "natural" conditions, so that the natural resources may not only be conserved but also developed to the best advantage. One example has just been quoted; of the many others, we may recall the development of special strains of grasses to improve hill pastures, with which the names of Sir George Stapledon and the Hill Pasture Research Station are associated; the increasing use of field-irrigation in Britain, which permits the taking of several crops a year from the one area; the planting of *spartina* and other grasses to check the movement of sand dunes, and enterprises such as the Anti-locust Survey, to locate and destroy the swarms of locusts before they move off to inflict incalculable losses upon the food resources of northern Africa and south-western Asia. Of course, there is a debit side—the damage following the introduction of the rabbit into Australia is well-known; as is the threat of the spread of the water hyacinth

of a balance between the various elements; the more stable the balance and the finer the adjustments, other things being equal, the more stable and successful the community will be. Human societies, from this point of view, are the subject-matter of human geography. These communities take very varied forms. Three examples from Western Europe are: a compact Tyrolean village, clustered around its spired church, set among open strips of cultivated land on the fertile bench above the rapid mountain stream, with the mountain slopes of dark forest and pasture dominating the scene; an English village straggling around the village green and sheltered by elm and oak, with wide expanses of pasture and arable criss-crossed by hedge and ditch under a cloud-swept sky; a Tuscan village crowning its hill, among red roofs and whitewashed walls reflecting the fierce sunlight, in the midst of dun-coloured, featureless fields with no animals to be seen.

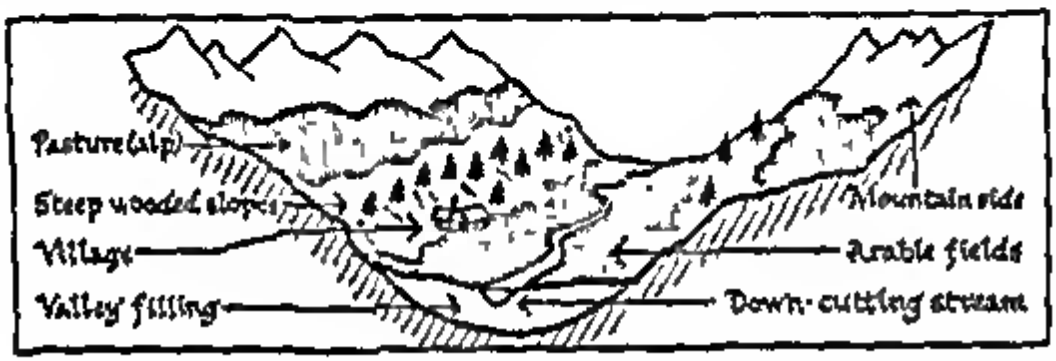
All these are expressions of the human geography of their respective regions, reflecting a way of life. But these are not isolated units, pursuing their own courses in isolation. The Tyrolean village is linked with its Alp, or high summer pasture, as it is with the larger settlement lower down the valley by post-road or narrow-gauge railway and to other markets further afield. In another sense, it is linked with Vienna, its national capital, in so far as government subsidies support a peasant agriculture which might otherwise fare badly in a highly competitive world. Finally, no insignificant part of its income is derived from the numerous visitors who in summer seek it out for its clear air and sunshine, its tranquillity and the delights of mountain and forest, or in winter as a ski-ing centre, known for its long, clear slopes of firm snow and winter sunshine. It is hardly too much to say that it in fact sells many of its geographical advantages to the tourist and sportsman. On the other hand, such a way of life may be extremely vulnerable to change in the outside world; a reversal of agricultural policy, however inconceivable at the moment, might well bring disaster, or a new fashion in holidays direct the profitable stream of visitors to other centres.

Each "manner of living" finds expression in the character and form of its settlements, the methods by which it earns a livelihood, and its links with the outside world. To a greater

or lesser extent it will also be influenced by custom and culture. The ban, for religious reasons, on the slaughter of cows in India has prevented the growth of an adequate pastoral industry. The apparent dislike of the Irish for fish as a food has held back the exploitation of the fishing grounds off the coasts. The adherence of Belgium to Roman laws of inheritance has resulted in the breaking-down of viable agricultural holdings into innumerable small parcels of land, too small or too scattered to be economic, and has presented the government with the vast and intricate problem of consolidating them into workable units. It should be remarked, however, that a less drastic solution of this problem has been reached in areas where workers had been able to combine part-time employment in industry with the cultivation of their minute holdings. Another aspect of this problem is seen in the Irish countryside; there, to avoid breaking-up the holding, it is customary for it to be understood that it will pass intact to the eldest son on the death of his father. Though this succeeds in its main purpose, it has had some unfortunate social effects. The younger sons will be obliged to seek a living elsewhere, perhaps in Dublin or more probably overseas, in Britain or the United States. Thus a shortage of farm labour is the result, since the holding is too small to support several workers. Again, although the eldest son will probably be middle-aged before he comes into his inheritance, he is likely still to be unmarried. Thus, inheritance customs, by encouraging late marriages, have an important effect upon agriculture and on population trends. Comparing Belgian and Irish experiences, it will be seen that size of holdings are not necessarily related to geographical conditions. An overriding factor in this respect is the strength of custom within the community.

The pattern of life in such communities depends on the geographical setting, the nature of the principal activities and the changing seasons. A rhythm is established which runs throughout each year. Some of the points made above will be clearer from the following description of two communities, one in western the other in south-eastern Europe. The first is an Alpine commune, St. Cristophe-en-Oisans, one of the most extensive in France. At an elevation of some 4,500 feet,

it is in a virtual mountain cul-de-sac, closed by a mountain wall rising to summits of 13,000 feet. Tectonic pressure has distorted and riven the granite and gneiss, and strong glaciation has further deepened the narrow valleys, encumbered by frequent and massive slides of rock-debris. Through the gloomy valleys, their bare, precipitous sides for the most part treeless and gashed by ravines, the river Venéon and its tributaries rush down their boulder-strewn beds. For half the year, the basin lies under a deep snow-cover, and the single road is regularly blocked for a time every winter. Yet until the middle of the last century, a community of six hundred



5. Diagram, not to scale, of an Alpine valley; relation of land use to relief.

persons lived in this harsh setting. The rhythm of life has two phases, six months of enforced and monotonous idleness, followed by six months of feverish and back-breaking labour. In April, the small fields, scattered near the river, must be cleared of snow (this is assisted by spreading debris over the surface) and then of the boulders and stones brought down by rock-falls and avalanches. In some years cultivation cannot begin until late April, and potato-planting is delayed until early June. During the summer, often wet and stormy, the farmers contend with flooding, due to melting water, first from the snow, then from the glaciers. Everything is carried to and from the fields by mules, including hay for winter fodder from the higher slopes, and sometimes by the farmers themselves. An additional burden arises from the necessity to irrigate the fields, owing to the coarse, stony character of the thin, poorly developed soils. In these conditions, the total

cultivated areas is small, and yields of spring rye low, though on the more favourable sites potatoes do better. Latterly, small areas of artificial pastures have been sown, but the cattle, sheep and goats depend almost entirely upon rough grazing (about half the area of the commune) and the mountain hay. Fruit trees are scarce and poor, since the commune lies near their upper limit. None of the harvest is sold from the farms, the sole cash return being from the sale of lambs and a few mules. Life is rendered harsher because some hamlets and farms, owing to the scarcity of safe sites in this rugged topography, are often placed on the shaded rather than the sunny sides of the valleys, so that they receive little direct sunlight in the winter. Formerly, some income was earned by shepherds who drove their flocks up the valley for summer pasture, and, in reverse, some local men found seasonal employment as shepherds elsewhere. An income was also earned by those who launched out as *colporteurs* or travelling salesmen, tramping the roads from house to house over a very wide area. Both these sources of income, however, have now ceased.

In these conditions, it was perhaps inevitable that permanent migration should be heavy, and that the population should decline. The exodus was greatly accelerated by the 1914-18 war and by the opening of the road in 1928. Since migration chiefly attracted the younger people, the natural growth has also declined, because of an ageing population rather than because of a fall in the birth-rate. As a result, by 1951, scarcely two hundred people remained in the commune.

In an endeavour to check this decline, efforts have been made to develop the tourist traffic. Because of its natural setting, the district has for years been a well-known mountaineering centre, and this provided additional income for some local guides and a few hotel-keepers. But there are limitations to expansion in this direction. Self-reliant, isolated and hard-worked, the inhabitants have in the past been little given to welcoming strangers. The season is short, the valley is isolated and the austere scenery does not appeal to the modern tourist. It is the dedicated mountaineer alone who is attracted. Here, state regulation of the guides has tended to operate unfavourably against the local man, and, in any case, a man already

overworked as cultivator, shepherd and perhaps hotel-keeper, has little time or inclination to shoulder further tasks.

The community further suffered a considerable blow when the authorities decided that the local and migratory flocks were destroying the pasture by over-grazing. The numbers were accordingly limited, a tax imposed, and a considerable area purchased as a nature reserve. Since the population a century ago stood at six hundred persons, it cannot be concluded that local geography precludes settlement of the Venéon basin; in fact, the inhabitants have displayed much resource and tenacity in exploiting the terrain. On the face of it, one might conclude that external authority has been responsible, as in the case of the shepherds and the guides, in hastening the decline.

The second example is a small farm in Greece, on the lower slopes of the hills overlooking the plain of Argos. Most of the rain falls in winter, and from April to October there is a long, hot drought. The rainfall is variable and often erratic, but there are springs at the junction of the limestones and schists. The total size of the farmer's holding is less than twelve acres, and is divided up into small portions, some at a considerable distance from the dwelling. His principal crops are grain, including wheat, and tobacco, and olive trees are scattered through the fields. Horses, mules, donkeys and sheep are numerous. Most of the work is done by his family, but when pressure is great, migrant labour may be hired. Spring is one of the busiest times; the winter-sown wheat must be cut with sickles; if these fields are to be in tobacco, they must be ploughed and the tobacco put in. Wheat and tobacco are sown alternatively with a period of fallow between. The next peak falls in August, when the heavy work of harvesting the tobacco must be done. In the autumn, there is the fallow to be ploughed for grain, and with winter comes the olive harvest. Most of the grain is grown to feed the draught animals, required for ploughing, carrying the harvest to the barns, and transporting the family to the distant fields. Up to half the wheat produced, however, is used for flour, the bread being baked in the farmhouse. If the family is large and one member can be spared as shepherd, a flock of sheep is kept. This flock is on the stubble, after the grain harvest from April to the

following spring; the remainder of the time it spends on the hillsides—no fodder being grown specially for its upkeep. The farmer depends for cash first upon the tobacco crop, secondly on the oil from the olives, and then, if he maintains a flock, on the meat or wool. In addition he provides for his family bread and meat. The local villages have few, if any, shops; the nearest centre for other needs is the large town of Argolis.

While the farmer is dependent upon an outside market for his cash, he is to a large extent self-supporting. But he is also dependent upon the weather; unseasonable weather during the growing seasons or harvests materially reduce his rewards. This type of farming is "a way of life" rather than an industry; the main consideration is not so much whether the products are competitive on the local or international market; the system maintains a population on the land for which no outlet in industry exists. It is for such reasons that many governments take special steps to protect their agriculture, in this instance by the support of tobacco growing.

Rhythms of this type can be discerned in all communities. The rhythm of an industrial community for example, in Britain, will be less variable but will be equally confined within a definite area. For the greater part of the year, the day will commence with the "journey to work," rarely on foot nowadays, more probably by bus, train, or the worker's own car, and the distances travelled may be considerable. After the day's work, there follows the trek homewards. This is repeated five days a week, broken at the week-end by some form of mass amusement. The longer breaks occur at Easter, and in August when for two weeks he may take his family to a holiday resort, or increasingly as far afield as the Italian Riviera or Spain. Finally there is the Christmas holiday, now usually four or five days. This rhythm may be interrupted directly by severe weather during the winter months, in the out-door trades such as construction and building, but frost or heavy snow can also result in other trades being "laid off" through the effect on transport, the delivery of materials, and the supply of power. Dominating it all, are the effects of wider trends, *in the national or international economic situation*. At first sight, it might appear that geography has less influence

on this industrial rhythm than on the other types cited above. But it is clearly to be seen in the effects of climate and the nature of the local topography. The efficiency of a port will be related to the features of its sea or river approaches—navigable channels, depth of water, tides—and the proximity of large level areas of land for dock installations. The topography also affects the nature and length of the journey to work. In a mining district, the relative accessibility and the character of the workable seams are important in the daily life of the miners, apart from their effect on the profitability of the mines. On the other hand, in many respects an industrial area is independent of geographical conditions in its immediate locality. Some part of the materials used in the factories is in most cases brought from considerable distances, and by far the greater part of its food supplies are grown outside the area. Enterprise and skill can also overcome or considerably reduce the handicaps of the site. But the sources of raw materials and food supplies are themselves subject to geographical influences, as are the supply routes. Bad harvests or impoverished markets in the outer world can have their repercussions on a west European industrial zone. It would therefore be more accurate to conclude that the influence of geography has become less immediately apparent and more subtle; an increasing range of minor handicaps can be overcome, but no area can be isolated from the broad framework, or insulated from geographical change. Modern techniques make the interrelationship more finely adjusted.

Up to this point, we have been examining the relations of smaller social units to their environment—village, small town or industrial zone—but the same approach can be made to an ascending scale of units: regions, nations and international groupings of powers. With this increase in scale the interrelationships and problems grow in complexity, but the changes are in degree rather than in kind. The village and the industrial zone take their place in a wider grouping, and the links which bind them together assume greater importance.

These ways of life, in which social, economic, and political strands are interwoven, are associated with definite areas on the earth's surface, and as such can be marked out on the

6. The world: principal areas of human activities.

map. In practice, it is not possible to give each a sharply defined boundary. While, for instance, the rainfall may be closely correlated with the relief, the administrative boundary, for historical reasons, may not. This is perhaps too simple an example, and in the modern world much more complex conditions can arise. A densely populated industrial centre can, by reasons of its very size, offer many more services, amenities, and opportunities than smaller surrounding towns, so that its region in terms of its "way of life" may extend far beyond boundaries narrowly defined in terms of topography or natural resources. Metropolitan city areas are a case in point. Greater London, defined as the area whose inhabitants in the main look for their daily employment to the industrial, commercial business and administrative concentration which has grown up around two small hills on the north bank of the lower Thames, has imposed its own image on an area of considerable diversity. For this reason, in human geography it is enlightening to regard a region as an area over which a particular centre exerts its influence. The trite simile of the ripples caused by dropping a stone in a pond comes to mind here. The original impetus to its growth may be one of many; a defensible, strategically placed strong-point in times of trouble; a convenient meeting-place for trade with "foreigners;" proximity to a valuable natural resource; a reputation for sanctity or scholarship. In many cases it will be a combination of several, or of one attracting to itself the others. No doubt there are several causes contributing to the growth of medieval Paris, but the reputation of its schools throughout Western Europe cannot be neglected. It is difficult to believe that Mecca and Medina would be the cities they are but for the place they occupy in the religion of Islam. Nor does it appear that any one of these factors is a necessity, that is, if we regard habitability and accessibility as relative terms only. From one point of view, the original site of Venice might well have been regarded as both inaccessible and uninhabitable. The site of London was not strikingly convenient for defence except at a very early stage; fortunately, throughout its history, it has rarely been called upon to withstand a siege.

The conception of a region as an area which has come, or been brought, under the influence of a centre possessing

certain advantages, has at least one merit. Its influence will decrease, other things being equal, with distance; consequently it will not have a precise boundary, but a transitional zone will separate it from the next. This obviates the necessity of drawing a hard-and-fast line on the map, a concept of which geographers are usually wary.

It should now be clear that a continent or country can be divided into many varieties of regions, according to the ideas held by the geographer or the purpose they are required to serve. Many schemes for the regional division of England and Wales have been propounded from time to time. In 1946, England and Wales was divided into ten "Standard regions," to be used for many official purposes. Since geographical conditions are never static, it is inevitable that a particular regional scheme will sooner or later become out-dated, and that a final, ideal scheme is unlikely to be achieved. There are numerous instances where administrative units have been based upon general principles of geography: the Departments of France, instituted by the revolutionary regime, are well-known instances. These conformed largely to the river basins, as their names demonstrate. This was a sound principle at the time, but they have proved inconvenient in national life, and for economic organization they are now grouped in eighteen regions. In less developed areas than western Europe, it is easier to delimit regions which will provide an adequate framework for national life and progress. Provided it is, like all other geographical tools, used with discretion and an appreciation of its limitations, the concept of the region is of fundamental importance. Some, indeed, regard it as the central core of geography.

In this chapter, a summary survey has been made of part of the field of human geography. One point at least should have emerged: the large number of topics which must come under consideration in any attempt to place man firmly and squarely in his environment. Without overlooking the essential unity of the theme, it is customary, therefore, if only for practical purposes of study, to sub-divide the subject. The commonly used headings are *Social Geography*, dealing with the organization and life of communities—types of settle-

ment, population growth and distribution, land tenure, etc.; *Economic Geography*, the exploitation of natural resources, exchange of commodities, communications, location of industry, international trade; *Political Geography*, the distribution of political units and their boundaries, the elements of national power, international politics viewed geographically; *Military Geography;* and *Historical Geography*, in its widest sense the re-creation of the geography of the past. A phrase commonly used today is "applied geography," often in the sense of regional or national planning. Its use can be misleading if it implies a difference between "geography" and "applied geography." The latter is simply the application by a geographer of his geographical training, knowledge and techniques to the solution of a given problem. Historical geography, in this sense, is as much applied geography as town or regional planning. But the term is useful in so far as it emphasizes that geography is not something in a book or on a map, but an organized and developing body of knowledge with an essential contribution to make to modern life. The geographer does not dictate; like a constitutional monarch, he is entitled to receive information, to advise and to warn. The ultimate decisions rest with governments and nations—hence the need for an informed public opinion.

CHAPTER NINE

Population and Settlement

In earlier chapters it has been seen that in the past constant attempts were made to find simple statements to clarify the relations of man to his environment. Most of these proved inadequate, first because of an insufficiency of observed facts, and secondly because this relationship was conceived in a simple, indeed naive, way. More recently, the geographer has faced rather an embarrassment than a lack of facts. To a considerable extent through advances in other sciences, particularly anthropology and sociology, it is now appreciated that the problem is much more profound and requires treatment from an evolutionary point of view. Before tackling fundamental principles, modern geographers have devoted much study to the distribution of man in relation to the geographical features and conditions of the earth's surface, and to discovering how this has changed in the course of time. One obvious accompaniment of this distribution are the marks of man's handiwork on the land—the shelters he has erected for himself and his dependents, the fields he has cleared for his sustenance, the roads, canals and railroads he has built to promote communication and exchange with his fellows, and the quarries and mines he has excavated in his search for further resources, with all the other manifestations of centuries of toil. In all this he has modified, often very considerably, the character of the land.

These changes and installations, visible and to some extent invisible, make up what is now often described as the "cultural landscape," that is, the objects which meet the eye from an advantageous viewpoint. This "landscape" is the result of many factors, geographical, ethnographical, historical, economic and social, and the product of their interplay can be expressed in several ways. One of these is the distribution and density of population over the earth's surface. An examina-

tion of this feature will therefore provide one aspect of the content and methods of human geography. This is attempted in this chapter, but it must be made plain at the outset that the treatment is not comprehensive.

The earth appears, superficially at least, well suited to be the home of man. Neglecting for the moment standards of living conditions, work and cultural attainments, and taking a purely quantitative view, we must start with the fact that the population of the world during the last century has been increasing at a greatly accelerated rate. At a rough estimate, the total population stood at 1,250 millions in 1860. In the next ninety years this figure had doubled, to 2,500 millions. This growth, moreover, still continues and a world population of 4,000 millions has been forecast for the year 1975. Though the precise reasons for this gigantic leap forward may be disputable, this does not suggest that the environment in general is hostile to man; at least one can assume that some hazards of life have been overcome. A further consideration is that broadly speaking, if the special case of the Polar regions is excepted, man can exist at some level on the vast proportion of the land surface—from Tierra del Fuego in 55°S. latitude to 72°N. in Siberia; at sea-level on the Equator and at 10,000 feet on the Tibetan plateau or the high valleys of the Andes.

	Mean Monthly Temperature		Relative Humidity		Precipitation Average		
	Jan.	*July*	*Jan*	*July*	*Jan.*	*July*	*Annual*
Verkhoyansk Siberia. 528 ft.	−58·5°F	56·5°F.	70	49	0·2 in.	1·1 in.	5·3 in.
London (Greenwich) 149 ft.	39·5°F	64°F	80	51	2·0 in.	2·0 in.	22·9 in.
Vienna 664 ft	30°F.	67°F.	74	51	1·5 in	3·0 in.	25·6 in.
Cairo (Helwan) 381 ft.	56°F	85°F	40	24	0·2 in.	0·0 in.	1·1 in.
Singapore 53 ft.	79·5°F.	81·5°F.	78	72	9·9 in	6·7 in.	95·0 in.

Further than that, many areas of the world remain densely peopled despite the threat of disastrous floods, hurricanes, earthquakes or volcanic activity. There are, of course, limiting factors; man is not physiologically equipped to work at

altitudes of much over 8,000 feet. But in the case of heat or cold, the really significant factors are, in regions of extreme heat, the availability of adequate water supplies and in cold regions, the presence of plentiful food supplies.

A third consideration should be borne in mind, and to explain this let us examine briefly some of the marginal areas of population. In the Tierra del Fuego, the aboriginal people —the Alouf—are virtually extinct and the islands are deserted; and in the higher tributaries of the Amazon traversing the tropical rain forest the indigenous Indian tribes are dwindling away, as are the aborigines of Central Australia. These people are not disappearing primarily on account of a sudden change or deterioration in their "natural" environment. Having maintained a way of life for centuries and achieved a degree of equilibrium with their surroundings, they are now threatened with extinction by external forces, the introduction of new epidemics from which they were formerly exempt, or the activities of strangers which disturb the economics of their daily life and undermine their cultures. As a result their institutions, activities, in fact their whole way of life, lose their former significance when faced with a totally strange and unintelligible culture, and the tribes lapse into listless apathy. This is not to say that such decline is never due to localized causes; destruction of local food supplies by, e.g. over-fishing, the continual felling of trees inducing soil erosion and the loss of good soils, and prolonged inbreeding have produced depopulation, but in the last century at least, it is the intrusion of an external culture which has wrought wholesale destruction. The dominant cause, however, is psychological, not geographical. It might be argued, admittedly, that the reason why such cultural catastrophes have occurred is because the geographic conditions have inhibited the establishment of a growing, vigorous, and firmly rooted society, able to resist external pressures. Within limits, this is a valid criticism. But the fate of peoples, firmly established in apparently more favourable environments, show that similar disasters have overtaken them. The Aztec civilization, flourishing in the "favourable" environment of the uplands of Mexico, fell before the attack of a mere handful of Spanish Conquistadores, who then proceeded to ravage the

civilization in a highhanded and ruthless fashion. In such cases, however, where the original culture was relatively strong, a new civilization has arisen from the fusion of the two, as has happened in Mexico.

It is possible to carry the argument one stage further back, and to inquire as to what the Spaniards owed their temporarily overwhelming superiority. The short answer is personal attributes—stamina, courage and determination—combined with technological superiority and experience in the art of war. With these must be placed psychological considerations; the invaders arrived at, for them, a fortunate moment in the history of the Aztec despotism, when dynastic differences were rife, and they appeared to be the fulfilment of ancient prophecies. But the most hardened supporter of "geographical determinism" could scarcely argue that the Spaniards owed these advantages to some inherent virtues in the geography of Spain.

This line of argument has taken us rather far from the discussion of the distribution of man over the earth, but it brings home the complexities of the subject and the danger of the too facile acceptance of geography as a universal key to cultural and historical problems. At the other end of the scale, the areas of high population density cannot be correlated with a particular climatic-vegetation region. From this restricted viewpoint, there is little in common between the West European industrial-urban region or the teeming arable lands of the Indo-Gangetic plain. Nor, in fact, do the low-density areas—the Tibetan plateau, Southern Arabia or the tropical rain forest of the Amazon basin—display significant similarities.

The increase in world population noted above has another important characteristic. This growth is world-wide since it is found in every independent political unit today (the population of the Irish Republic is a special case—its population would increase by natural growth but for large-scale emigration). For statistical purposes, the United Nations Organization divides the countries of the world into nineteen groups; in the period 1950-55, all these groups showed increases, though the increase varied considerably, from 2·6 to 15·35 per cent, and in all countries, with the exception of India, the

rate of increase was accelerating. These rates of growth conceal a number of individual characteristics; a relatively low density with rapid growth (most African countries); high density and moderate growth (Europe); and high density with rapid growth (South-East Asia). In a detailed study of population numerous other factors must be taken into account; birth rate, expectancy of life, age-structure, proportion of the sexes, etc., but what has been said above is sufficient to demonstrate that man can establish his home in most parts of the earth and that population density cannot be directly correlated with position on the globe. These figures of course conceal one vital and obvious fact—that there are areas within the political units in which the population is decreasing. In Britain "the drift to the South" has become notorious, and is now the subject of constant comment in the national press. In France the depopulation of the Departments of the centre and south-west is reaching alarming proportions and measures to arrest it by decentralizing light industry are in train. In the Republic of Ireland, the countryside is declining through migration not only across the seas but to the Dublin region. The story is the same throughout Western Europe and the phenomenon appears in many other countries. In the United States of America, the movement westwards has recently gained renewed strength, so that California is now the most populous State in the Union. This has also accompanied a general movement to urban areas; since about 1940, the rural-farm population has steadily declined. These movements of population are often referred to as internal migration. But external migration, from one continent or political unit to another, the flow of peoples which built up the United States, Australia and other "new" lands, continues, though in diminished numbers. In the decade 1951-60, two and a half million immigrants entered the United States; this was the highest figure since the decade 1921-30, which stood at just over four million. In 1960, in round figures, a quarter of a million immigrants entered the country, of whom almost half were from Europe and most of the rest from other American countries.

It is apparent, therefore, from these general considerations, that the present distribution and movement of world popula-

tion is not entirely due to purely geographical causes. Certainly in internal migration, the general movement has been for the most part from the rural to the industrial and commercial areas, from the farms and villages to the great urban sprawls, though in highly industrialized countries there is also a trend away from the older centres of traditional heavy industries to centres of the new light industries, based on electrical power and in many cases employing a high proportion of women workers. All this suggests that some other influence is at work; it is in fact the tremendous advance in technology which underlies these changes; advances which first made themselves widely felt in the late eighteenth century, but which have also produced a second "industrial revolution" in our time. Some of these changes will be discussed later. Here it may be noted that they have affected both agriculture and industry, and that they have certainly not eliminated geographical considerations. Georgraphical factors operate to the advantage or disadvantage of localities within an area of population exodus, or increase the attractive power of one industrial centre over another.

Before examining the broad effects of these technological changes, it is necessary to trace the geography of settlement in the earlier, or subsistence stage, most clearly seen in the older settled countries of Western Europe. Man's requirements in the early phases of a settled life are twofold—subsistence and security. The first presupposes a fairly regular supply of food and water, and of material for clothes, as a protection against the weather, and for tools; the second, a site for his dwelling which will be reasonably free from sudden natural catastrophes—floods, avalanches, inroads from the sea, etc.—the ravages of disease, and the attacks of human enemies. These two desires will obviously interact; to secure access to areas of good soil, it may be necessary to accept a site lacking some desirable quality; for example, rich alluvial soil may bring exposure to malaria, in which case it may be better on balance to select a hill-top site some distance from the cultivated area, despite the disadvantage of a long journey at morning and nightfall, plus the difficulty of providing an adequate water supply. Similarly, though defence may be an important consideration, no site with the necessary qualities

may be forthcoming; in this instance, the hazard must be accepted or, in times of threatening danger, removal to a stronger refuge must be undertaken. It is not to be supposed that primary settlement proceeded in so conscious a fashion. Sites must often have been the results of trial and error. In many areas, particularly Western Europe, there have been successive waves of settlers, each wave bringing with it its own techniques and way of life, so that its choice of settlement site might very well differ from that of its predecessor. These considerations are clearly illustrated in the history of the English landscape. But before analysing it in a little more detail, it is necessary to consider some further general trends.

Except perhaps in conditions of absolute subsistence, communities have never been completely isolated from the outside world. Communication, contact and exchange, in varying degree, have had their influence upon the pattern of settlement. In these respects, local geography has been decisive. In Western Europe, rivers have throughout history afforded a relatively efficient means of communication, particularly in early times, when land travel, through uncleared country lacking in roads and perhaps with lawless populations, was difficult, slow and dangerous. In such conditions, river travel offered better prospects, especially for heavy materials. Thus strategically placed sites from which this traffic could be controlled, particularly if they also commanded a good crossing point, developed rapidly. It is scarcely necessary to emphasize the geographical superiority of the site of London in these respects, a compact, habitable area by the lowest river crossing and near the tidal limit, consequently a natural site for a sea port from which goods might be forwarded by land or river. Such a site also, as a point of contact with "foreigners" and of exchange not only of merchandise but also of ideas, attracted increasing numbers of settlers. Similarly, over the countryside, favoured sites would emerge, first probably as convenient points for local markets (later as fairs for merchants from further afield) and for shelter in dangerous times. With the development of an ordered society, these would be convenient for the residence of officers of the central government and for the sees of bishops. Official recognition of their importance came with the grant of charters, royal, ecclesiastical or baron-

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ial, conferring rights of self-government in civic and trading affairs in return for financial contributions. In this way and in course of time there arose a hierarchy of settlements ranging from hamlet, village or manor, through the market town to the county town, city and episcopal see, culminating in industrial complex and metropolitan capital.

This generalized statement can be applied to England down to Defoe's day, with one important qualification, the effect of the gradual development of bonds with the world across the sea. From the fourteenth century, England had a most valuable export in wool, which served to stimulate the ports through which it passed to the continent—London, Southampton, the Cinque Ports, and Bristol, to name the most important. It must not be forgotten also that long before the eighteenth century, England was ceasing to be a rural and agricultural society, farming mainly for subsistence. Small, specialized industries had come into existence, based on local resources and using local power supplies, e.g. the iron industry of the Weald drawing on local supplies of ore, water power and fuel from the woodland on the Wealden clays, and the cloth mills of the Pennines, based on a plentiful water supply and the local flocks of sheep.

Working on these lines, it is possible to classify early sites in various ways. Wet-point villages are those whose sites are determined by the presence of water, especially in limestone country. The villages at the foot of the northern slopes of the South Downs, where springs issue from the junction of the chalk with the impervious greensands, are a well-known example; the oases of the western desert of Egypt are another. Dry-point villages are those which afford refuge from water, such as the settlements along the dykes in North Holland, or the Egyptian villages on mounds, more or less artificial, which are slightly above the level of the alluvium and the periodic floods of the Nile delta. Other classes include strong-point villages, already mentioned, and food-point villages, those sited on the restricted areas of arable in otherwise infertile country, as at the heads of Norwegian fjords. Such classifications are useful guides, provided that it is remembered that they are not exclusive, i.e. a strong point can also be a wet- or dry-point village. The character of these villages is reflected

in their plans. The lay-out of the type of North Holland village is necessarily controlled by the dyke on which it is built, just as the cluster of an Egyptian village is related to the mound which raises it above flood level.

The types of small settlements so far mentioned are in general agglomerations of dwellings, or nucleated settlements. But in many areas the typical settlement pattern is dispersed or disseminated, that is, the farmsteads are distributed in single units or small hamlets over the countryside. The reasons for this distribution are varied; in some instances it reflects the type of farming; cattle and sheep raising, owing to the relatively large area required, is often best carried on from dispersed farmsteads, as on the sheep farms of the Welsh hills or the great sheep runs of New South Wales. It may also be based on widely distributed supplies of water. The type of land tenure and the farming technique followed, however, have often determined the character of settlement. When western America was being opened up, the general practice was to divide the land into townships six miles square, and to sub-divide these into thirty-six sections of one square mile each. It was natural therefore for the settler to build his farm on his holding. In this way, the rural population was widely scattered, and the rural centre was a small group of buildings, store, post office, church, school, serving the needs of the immediate neighbourhood. In Ireland an example of the influence of land tenure on settlement may be noted; in the west, until the mid-nineteenth century, large villages were common, standing in the midst of the great landowners' property. When these big estates were broken up and allocated to the peasantry, the latter generally set up homes on their holdings, thus returning to the conditions which had preceded the consolidation of the big estates. The influence of tenure can also be seen in Northern France.

A similar influence can also be traced in the history of settlement in Britain. Over much of southern and south-eastern England, a characteristic settlement was the "nucleated" village, standing in its open fields, in which the individual cultivated his several strips. As the result of economic and social changes, particularly in the eighteenth and early nineteenth centuries, these "strips" with the common land

were consolidated or enclosed into independent farm units, with a tendency for the farmers to build their homes away from the village. From these enclosures also date the hedgerows and accommodation roads, often tree-lined, that are characteristic of much of the English countryside.

The character of a long-settled countryside—its cultural landscape—is the product of the interaction of geography and history (space and time), and their respective roles may not be apparent, at least at first sight. At one time it was fashionable, for instance, to regard the "nucleated" village of south-east England as being essentially Germanic in origin, and the dispersed dwellings of the south-west as of Celtic origin. This is over-simplification, at the least, and geographical and other factors cannot be disregarded. As in many other aspects, geography must be studied in depth, or, perhaps more accurately, in time.

Up to this point, in so far at least as the English cultural landscape has been examined, the standpoint has been pre-Industrial revolution. Provided it is recognized that this "revolution" was a process rather than an event, and that though its full impact was felt in the late eighteenth and early nineteenth century, its roots are to be discerned much earlier, this was a significant and shattering event. Again generalizing perhaps a little rashly, its significance for the geographer resides in three main considerations: the release of previously ill-utilized or new sources of energy; the replacement of small local workshops satisfying local needs by large scale industrial enterprises producing for national and eventually world-wide, rather than local, markets, drawing at first on local resources of materials and labour, but gradually extending its demands on both further and further afield; the growth of complex financial and trade policies to hold highly competitive markets. It is not necessary to outline here the growth of the so-called capitalist system, its ramifications and modifications, but the geographer cannot disregard its effects and implications for his subject, particularly in the concentration and increasing size of the enterprises.

The main effects on the cultural landscape of the revolution arise from the exploitation of mineral resources for fuel and power, and of minerals, plant and animal resources for manu-

facturing. Complementary to these are the concentration of population in new, industrial areas and a gigantic development of communications, both to distribute the manufactured products and to tap sources of raw materials and minerals. In the early days, it was generally the practice for the new industries to establish themselves close to the source of the bulkiest raw material, to reduce transport costs. For this reason, many industries were first established on or near the main coalfields. On the other hand, industries using water power were restricted to the source of the energy, until the introduction of electrical power provided a method of transmitting the energy over long distances. It should be noted that from the start of this revolution, the necessary raw materials were often drawn from considerable distances. The most notable example is that of the Lancashire cotton industry; taking advantage first of the power provided by the Pennine streams, then of the local coalfields, the supply of labour skilled in traditional manufacturing methods, and the proximity of Liverpool as a port of entry and despatch, the cotton magnates imported large quantities of cotton from the southern United States, and exported their cotton cloth over the world. When local supplies proved insufficient, other industries were obliged to seek new sources of supply further afield, hence the import of iron ore from northern Spain and of wool from New South Wales.

The growth of industry thus transformed the distribution of population throughout the country. At a time when agriculture was beginning to feel the growing competition from overseas, hundreds of thousands left the countryside for the great centres of the Black Country, Lancashire, the North-East, the Central Lowlands of Scotland, South Wales and London. These migrants came not only from the rural districts of England and Wales but from all over the British Isles, and very markedly from Ireland. There, for many reasons, the countryside was undergoing an even more serious crisis, and having no industrial areas of any size, the migrants were obliged to seek employment in the United States, Britain, and, to a lesser extent, Australia.

London was a special case in that it had no heavy industries comparable to those of the North. Its attraction derived from

of newcomers who had invested in them the fortunes derived from industrial development. Away from the main routes, dusty country roads wound their way between hedges from village to village. Few towns and fewer villages had greatly altered their plans for centuries. The coming of the railways had affected them to a surprisingly small extent, except through the addition of railway yards and sidings at junctions in the railway network. Those away from the railways were left to themselves, their only connection with the outside world being by horse-drawn waggon or carriage, though with the coming of the bicycle and the automobile the life of the old coaching inns was beginning to revive. Less than fifty years ago it was possible to encounter a farm labourer in Sussex who performed his weekly shave with a piece of broken glass, and, ten years later, to take a twenty-mile walk from a point less than ten miles from the centre of London by field paths and green lanes without crossing a main road more than once or twice. Along the coasts, particularly in the south-east and south, and in the moorlands and mountains of the North, the vogue for the outdoors and for "walking tours" brought some profit to the smaller villages away from the popular seaside resorts. It is easy to become lyrical over the delights of an era that has passed irrevocably away; but there was a less picturesque side. To whatever extent it was supplemented by free produce and the fruits of the cottage garden, the monetary wage of a farm labourer even at prevailing prices afforded little margin for creature comforts, and a bad harvest meant widespread distress or failure. In view of the condition of agriculture, this was not altogether to be blamed on the farmers. Lack of public services meant that water supplies and sanitary installations were unreliable or crude. No doubt those who attacked the "back to the land" slogans dear to some Victorian reformers were correct in dismissing them as sentimental and impracticable in existing conditions. The pity was that those who left the land for the cities often found little to reward them there, and that the lot of those remaining was so little improved by these departures. The rural population in many cases at least possessed a sense of social coherence and stability, suffering the strokes of ill-fortune and celebrating the seasonal festivals together. It may

sound mere romanticizing to some ears, but it is true to say that many of them felt that they had their place in the natural order of things. Those who left for the great industrial areas in the early days found themselves in many ways in worse plight, at least until the reforms of later Victorian times. Whatever security they may have possessed was lost while they remained at the mercy of the employer or the state of the market. Their surroundings, crowded into tenements or long rows of back-to-back housing, under the smoke pall from pit or factory, were certainly no better than those they had turned their backs upon; and it was only gradually, through the trade union, church, chapel or public house, that they forged some degree of social unity. In time, however, the consciousness of economic and political identity was accompanied by power beyond any they had known previously. To many the greatest gain was opportunity—for the advancement of themselves and their families, generally economic but to some degree social and cultural. Not a few found in the mechanic's institute or the town library the means to improvement which would, save in exceptional cases, have eluded them in the depths of rural England.

Such considerations may seem remote from a study of the "cultural landscape" but most of them found physical expression in it, and can be traced in the "urban landscape" of today. The concentration of poor housing round factories, docks and railway centres; the ring of better residential areas at increasing distances from the city centre, to which the successful industrialist or business man withdrew; the accompanying decay of the older residential quarters as town houses declined into tenements; the rise in land values in the centre as commercial interests, exploiting the potentialities of the site, strove for mastery in a competitive world; the loss of individuality of formerly self-sufficient villages and small towns beyond the city boundary, and their absorption by the outward-flowing tide of housing; all these features can be disentangled from the map of any large urban centre. To list them is not to condemn the nineteenth century out-of-hand. From a very early stage, men strove to mitigate their worst evils, but the problems were new, and were developing against a rapidly changing background not only at home but

also overseas. Unless some concept of their development and complexity is achieved, it is impossible to grasp firmly what human geography is really concerned with.

Technological advances have been accompanied generally in the West by rises in the material standards of life. While these enable people to withstand the harsher elements of climate and relative isolation, they induce also a desire to escape to a less rigorous environment. The "drift to the South" in Britain is certainly motivated in part by this desire. But just as in Britain the business man and the invalid look forward eventually to enjoying the more genial conditions of the South coast, so the farmer in Montana looks forward to retirement to California and the Belgian industrialist to a villa on the Riviera. But these changes in standards have a more fundamental importance. It is improbable that, in modern conditions, European families would face the discomforts, hardships and changes which confronted the immigrants who in the last century "won the West" for the United States, or pioneered the development of the Australian interior. The Highlands of Scotland, it is probable, supported a greater population when subsistence farming was at its peak than they do today, despite measures to develop selected resources. This means that in present conditions, the age of large-scale agricultural expansion by large numbers of immigrant settlers has passed, except perhaps inside the Socialist bloc. On the other hand, the improvement of amenities, the provision of piped water supplies and electricity, and the coming of the motor-car and the radio, have done something to check the flight from the land. The development of new agricultural land need not, however, necessarily cease, but it is likely to be a highly mechanized operation requiring high capital outlay and a small, highly skilled and highly paid labour force. Overseas emigration has therefore undergone a change; if 60,000 emigrants left Britain for Australia in 1961, it is safe to say that few were of the earlier type, but skilled or semi-skilled men intent on finding places in a modern industrial society.

These last two chapters have failed if they have not demonstrated the variety of the subject matter of geography, broadly interpreted. There is the physical environment, often im-

mutable in the eyes of man, but subject to not inconsiderable changes and modifications, some indeed induced by man himself. Within this environment, human communities strive to maintain their identities and to improve at least the material conditions of their members. In this they may take account of, ignore, or even defy the changing physical environment and the trends in the outer world. In doing so, their actions will be influenced by many considerations inherent in their own history, material, cultural and spiritual, and the result will be a resolution of all these forces. Time as well as place has its role in geography. It is rather profitless to speculate whether geography (in the limited sense of the physical environment) is exercising an increasing or diminishing influence on human affairs. The geographical importance of a particular physical feature of the earth's surface is strictly relative to a particular moment in time. The English Channel was in prehistoric times the means by which cultures spread from the continent to these islands; in the early Middle Ages it formed a vital trade artery; a century and a half ago it was a barrier to a Napoleonic invasion; what is its precise role today? Or consider our position on the globe; recall the *mappae mundi* of the Middle Ages, with the British Isles on the extreme edge of the known world, and compare them with a nineteenth-century Mercator chart, and the ocean routes radiating almost literally to every "corner" of the world. Sir Henry Newbold is not highly regarded as a poet in many circles today, but he was not far off the target when he wrote the lines

> "Time and the ocean and some fostering star
> In high cabal have made us what we are."

To take perhaps a less happy metaphor; is it too fanciful to see the cultural landscape today as a print from a metallic plate of varying composition, texture and regularity of surface, on which a corrosive fluid—human activity in all its manifestations and with all its experiences—has worked out a pattern, etching out a line of weakness here, leaving an impurity there, but definitely imparting a new surface to the plate. The metaphor might be pursued farther, if we imagine

a series of pulls to be taken from the plate at varying temperatures and atmospheric conditions with a fluid of varying strengths and slightly different properties. The resulting pulls, without stretching the comparison too far, may be taken to represent maps of the cultural landscape of a region at various stages in its development.

If eternal vigilance is the price of liberty, it is also at a lower level the duty of the geographer. He must, to the utmost of his ability, view his problem as a whole in the context of space and time, rejecting the immediate, superficially attractive, explanations, exploring all possible solutions in depth and above all avoiding dogmatism.

In the chapters which follow, an attempt is made to apply the principles which have been outlined up to this point to some problems of the modern world. For convenience of study, if for no other reason, geography is conventionally organized in sub-divisions. Rather than classify these chapters as political geography, economic geography and so forth, I hope they can be regarded as "geographical thinking" on matters of present importance.

CHAPTER TEN

Boundaries and their Politics

POLITICAL geography can perhaps be more clearly understood as "the geography of political units," that is, the distribution of States on the land surface and their relationship to their environment and natural resources. Since every unit must have limits, an important element in political geography is the study of boundaries. A boundary is a definite line dividing a State from its neighbours; a frontier is more accurately a zone of transition between two States. Where therefore, a boundary has not been delimited or demarcated, the intervening area is properly a frontier or frontier zone. A boundary is delimited in a technical sense when it is described verbally or laid down on a map, as in a peace treaty; it is demarcated when a commission has marked it on the ground, in accordance with the agreement, by boundary pillars or similar means. It often comes as a surprise to realize that a considerable proportion of the boundaries on the world may have never been demarcated, and a fair number have not been delimited, that is, there is no boundary treaty between the States directly concerned. In many cases, however, where there is disagreement, a provisional boundary is recognized for practical purposes. There are numerous boundary disputes currently in progress; the present Jordan–Israel boundary is a *de facto* boundary, as is the boundary between West and East Germany; that between the Yemen and Saudi Arabia has never been delimited, and many more examples might be quoted. An important one, discussed later, is that of the northern boundaries of India.

Boundaries are often classified as "natural" or "geometrical." The former are delimited by specifying certain natural features which they will follow—the central line of a riverbed, the water parting between two river basins, or the crestline of a mountain range. The line can also be drawn to

include a particular feature within one of the States, or to divide it equally between rival powers. Where there are no suitable geographical features, or where the proposed boundary crosses a little-known or unmapped region, a boundary is sometimes defined as running in a straight line between two points whose positioos are stated in latitude and longitude. Such a line may later prove to be most inconvenient to one or both of the parties involved. It may be found to cut the territory of a tribe in two; or to deny a nomadic people access to seasonal water supplies. Central Africa affords an extreme case of the wide use of boundaries of this type, partly because much of it was not accurately mapped when it was partitioned by the Great Powers at the end of the last century, and partly because the Powers were in haste to establish their share. When this type of boundary is being demarcated, the commissioners are often empowered to make minor changes to avoid penalizing the local population too severely. When this type runs through desert or sparsely peopled country, it has much to commend it—its position is known from the outset and it is relatively simple to mark on the ground.

It might be concluded from the above that the "natural" boundary was usually superior. But this is not necessarily true. Most States have developed from the activities of a particular people in a particular region, and they have often radiated from a central, or kernel, area. In their advance their movements may have carried them at some points across a great river, otherwise suitable as a boundary, or over a water-parting and into the valleys on the further side. It may also be that by drawing a boundary along the limits of a river basin, one side has been denied easy access to the outside world. The position of a boundary can have a great, even critical, effect upon the development of a region. When it has been unchallenged for a considerable period between peoples with differing aims, economies and standards of living, it will have affected development on either side, and these results will be imprinted on the map. The lay-out of communications, for example, will clearly be related to the line of the boundary. Plans for an irrigation scheme may be dependent upon whether or not the upper reaches of the river are controlled by another State. The pattern of settlement,

even the size and shape of the fields, may change as the border is passed. The exploitation of minerals may be delayed if the most direct or less costly line of approach is under "foreign" control. The amount of capital available for investment can also differ in geographically adjacent areas. Thus boundaries are an important factor in the cultural landscape. Many of these inconveniences and others arising from the location of boundaries can and have been overcome by international co-operation. The Rhine forms a boundary between three West European States, yet its importance as a great commercial route has ensured that its use is controlled by an international body. Incidentally, the claim put forward by France in the seventeenth century that the Rhine was a "natural" frontier of the Kingdom is an early example of the use of this argument.

In Europe, existing inter-State boundaries result from a long and stormy history and a complex geography, and in many parts are still the cause of friction, but in Western Europe, at least, their worst inconveniences for a wider community life have been mitigated by agreement and adjustment. With the development of the "Common Market" organization, this trend will continue. Many thousands of workers cross the boundary between France and Belgium in either direction each day. Rail communication operates without the inconvenience of a break in gauge, and hydro-electric power is transmitted over long distances from one country to another. But elsewhere, and especially in developing countries, the geography of boundaries exerts powerful influence and raises difficult problems. This situation arises from their geographical characteristics, history, economic development, standards of life of the new States, and the international situation.

Reference has already been made to some of the difficulties created in Africa by nineteenth-century boundary practice. In West Africa, the ill-effects of "geometrical boundaries" were re-inforced by the fact that these were carried inland, perpendicular to the coast, thus producing in some instances political units without any obvious geographical or ethnical unity. From some aspects, the present boundaries of the Congo Republic are largely accidental, depending upon the

balance between the Great Powers. Rivers, which do not always make the best boundaries, were frequently used, and little attention was paid to tribal units.

The history of the boundary between the United States and Canada illustrates very clearly the difficulties which can arise in boundary-making from agreements reached in ignorance of the topography, a complicated topography, the particular type of boundary chosen, and from confused or careless drafting of a treaty. This is a long story, but one portion is particularly enlightening. The British and American commissioners who defined the boundary in the Treaty of Paris (1783) used the map of John Mitchell published thirty years earlier—a map based largely on rough surveys and sketches with a very poor foundation in latitude and longitude. The portion of the treaty relating to the Lake of the Woods region stated that the boundary line should run "through Lake Superior northward of the Isles Royal and Phelipeaux, to the Long Lake, and the water communication between it and the Lake of the Woods, to the said Lake of the Woods; thence through the said Lake to the most north-western point thereof, and from thence on a due west course to the River Mississippi. . . ." This seems a perfectly clear statement, but the Commissioners sent to demarcate the line found their task an impossibility. The two isles mentioned proved to be one and the same; the Long Lake could not be identified with certainty; there was no water communication between Lake Superior and the Lake of the Woods, since the river shown on Mitchell's map did not exist, and the northern shores of the Lake of the Woods were so indented that it was impossible to say where the most north-western point lay. Finally, since the Mississippi rose south of the Lake, a line running due west would never reach it. The last, most important point, was realized and settled first. On the British proposal, the reference to the Mississippi was omitted, and the 49th parallel of latitude was adopted. Eventually, by the Oregon Treaty, this parallel was extended to the Pacific coast. Thus one of the best known international boundaries originated as an afterthought. A position for the north-west corner of the Lake was agreed upon in 1826 and a line was cut south to the 49th parallel in 1872. The 49th parallel was carried west-

wards in 1872; considerable difficulties were experienced in locating it, and a treaty of 1908 provided for its re-marking. The expenditure in labour and money has therefore been very heavy. One interesting situation arose in this respect: a strip 500 feet wide was mapped on either side of this line and boundary marks were set up on each side of the houses intersected by it. No further building was to be permitted within a certain distance of the line, but those already standing on the demarcation line were not to be interfered with.

When a boundary is seen, as in a small-scale atlas-map, apparently to coincide with a mountain range, it is often assumed that it runs along the crest and makes a clean, tidy dividing line between the States on either side—in fact that it is a good example of a "natural" boundary. On examining such a boundary in detail, or on a larger-scale map, we may realise that the position is not so clear-cut. The northern boundaries of India are a case in point. This particular example is also worth examining more closely because, to understand it fully, we must study the characteristics of a great mountain system.

The boundaries of India (as a sub-continent) on the north are related to the high terrain which stands in such contrast to the lower valleys and plains to the south, in which a great proportion of the population is concentrated. The contrast is not so marked on the north-west; there the boundary lies west of the edge of the Afghanistan-Persian plateau, which is in general tilted towards the south-west. Approach to the plains from the west is controlled at two principal points where valleys breach this edge, at Quetta (Bolan Pass) and Peshawar (Khyber Pass). The obvious boundary in this direction might appear to be the rugged margin of the plateau. However, to protect this boundary, and to exercise some control over its restless and virile peoples, the government (pre-Partition) succeeded in establishing a boundary with Persia and Afghanistan on the plateau, and allowed the local tribesmen a certain degree of autonomy. In this sector therefore there is a boundary defined and delimited by treaty with Persia and Afghanistan, behind which lies a zone of partially administered territory. There a hostile threat could be contained at a distance

from the plains. The position remains much the same since the establishment of Pakistan as an independent sovereign State.

On the northern and north-eastern boundaries of India, the position is more complicated. The Himalayan mountain system has resulted from relatively recent earth movements when, owing to the development of a trough of crustal weakness, the mountains were thrust up to a great altitude. The system is a series of more or less parallel ranges, in section resembling wide flat arches with further relatively slight wrinkles, along which the great peaks lie. The ranges can be divided into two main groups: the Lesser Himalaya to the south, a series of related folds, and the Great Himalaya to the north, essentially a single range of great elevation. To the north again, lies the massive, high plateau of Tibet. The total longitudinal extent, including the south-eastern prolongation, is of the order of three thousand miles.

The relation of the regional watershed to these ranges is significant. Between the Sutlej and the Brahmaputra, all the main rivers rise to the north of, i.e. beyond the Great Himalaya range, and flow, with interruptions, southwards, that is, transversely across the ranges. These rivers appear to represent an early drainage pattern, having maintained their courses by down-cutting their beds as the mountain ranges rose. These rivers also tend to converge upon each other in the troughs. This is attributed to the more recent upheavals of the outer parallel ranges.

The effects of this structural history are numerous. In the first place, there is no high continuous crest-line, forming a well-defined water-parting between India and Central Asia: the water-parting lies on the Tibetan plateau, sometimes, as with the Shyok-Karakash divide, in an almost level area. Secondly, despite the wall-like array of great peaks and sheer mountain slopes, the Himalaya are not a continuous barrier, but are breached at numerous points; however, owing to the courses followed by the rivers, the transverse routes are tortuous and difficult, through deep, narrow valleys liable to sudden floods.

By contrast, the section between the Indus and Sutlej rivers is not cut by transverse valleys, the rivers in general flowing

longitudinally in the troughs, a fact which has a bearing upon the history of Kashmir. Through their position in relation to the path of the monsoons, the southern slopes of the Himalaya receive heavy rainfall, while the Tibetan plateau, in their rain-shadow, is relatively dry, and extremely cold in winter. The southern approach, therefore, is hampered by dense forest and frequently flooding rivers in summer, and in winter snow lies some three thousand feet lower on the southern slopes than on the northern. The permanent snow-line on the south is around 15,000 feet.

East of the Brahmaputra (Tsanpo) river, the system swings round almost through a right angle. In this region the general southward direction of the drainage is maintained by a number of great rivers, including the Salween and Mekong, the upper course of the most easterly of these having been apparently captured by the Yangtse Kiang. These rapidly flowing rivers have cut narrow, deep gorges, and make communication between India and China very difficult, as was demonstrated in the last war when the "Burma Road" was built.

In contrast to the productive, densely populated Indo-Gangetic plain on the south, the Himalyan system abuts on the north against the vast elevated plateau of Tibet, a "cold desert" suitable only for grazing except in small areas of more congenial climate, mainly in the south-east. This stark region has a scant population, averaging over the whole little more than six persons per square mile.

From even a brief study of the physical geography, one would not expect to find numerous populations, well-organized and prosperous, in the Himalaya. Settlement is confined to the valleys and the lower slopes. Along the central section there is one sizeable unit, the Kingdom of Nepal, and two smaller ones, Bhutan and Sikkim. The life of Nepal centres on the longitudinal valley of the Baghmati river around the capital, Katmandu, which owes a good deal to its position on one of the few routes northwards to Tibet. A more practical route via the Jelep La (14,500 ft.) runs northwards through Sikkim, which is little more than the upper valley of the Tista. Bhutan is a smaller version of Nepal without a central feature comparable to the "Valley of Nepal." These

States have been influenced culturally in the past from the south, notably by Buddhism, which now takes the form of Tibetan Lamaism. There has been also a certain infiltration from the plateau, and a number of the higher valleys are predominantly Tibetan.

British policy in India, largely from a desire to avoid being drawn too far into Central Asia and from readiness to accept the Himalaya as a sufficient bulwark was content to enter into special relationships with these native States, recognizing their independence and leaving them largely to their own devices. For many decades they remained isolated from outside influences, the home of a social and cultural way of life which was rapidly disappearing in the sub-continent to the south. It followed that economic development was not stimulated, little or nothing was done to improve communications and most of these areas remained unmapped.

This history has had important repercussions on the boundary question. In the course of time, certain limits have been accepted in the valleys, according to the degree of penetration from the north or south, so that in some instances the heads of valleys, where Nepalese influence is strong are traditionally part of Nepal, while others, where Tibetans have worked southwards down the valleys, are Tibetan. Apart from these instances, the general boundary shown on maps, which follows the crest-line fairly closely, is entirely conventional. No Nepalese territory lies to the north of it, and Mount Everest is astride the frontier.

At the north-western end of the range, the situation is rather different; the longitudinal, more open valleys have favoured the establishment of a relatively large political unit, Kashmir and Jammu, having historical links with both India and Pakistan. The point here is that the generally accepted northern boundary, resting on an agreement dating from the British regime (1842), is definitely beyond the main crest line of the Himalaya.

East of Bhutan, the situation is more complex, as conditions remained fluid for a much longer period. When the British annexed Assam, they were content to administer the lands immediately adjacent to the Brahmaputra. The administrative boundary on the north lay along the foot-hills of the

Himalaya. Beyond this line, however, the higher slopes and valleys were the homes of wild, primitive peoples, Daflas, Abors, Mishmis and others. To prevent strife and disorder on the administrative boundary, the British were eventually obliged to exert a rather vague sovereignty over the hill tribes and to extend their control progressively. No definite northern boundary was established but it was clear the British visualized this "unadministered area" as comprising the territory between the crest line, largely unexplored, and the foot of the mountains. In negotiations with the Tibetans and Chinese in 1911, an attempt was made to delimit the boundary. A line approximating to the crest-line, the now famous "McMahon Line," was drawn on a map which was signed by the Tibetan and British negotiators and initialled by the Chinese representative. Shortly afterwards the agreement was denounced by the Chinese but again accepted by Tibet and Britain. After independence the Indian Government continued to exercise control over the area. All connection, however, was not severed with Tibet; some monasteries, for example, continued to function within Tibetan jurisdiction.

In the past, Nepal, Sikkim and Bhutan recognized in a somewhat vague way the suzerainty of China. This continued in the case of Nepal despite the fact that the Nepalese drove the last Chinese army out of their country in 1792, and despite their special relationship with India. It also is worth noting that only one military force has, during the last two centuries, penetrated to the Tibetan plateau from the south, namely the British-Indian expedition of 1904, under Sir Francis Younghusband. With the "liberation" of Tibet, the Chinese re-asserted their suzerainty and refused to recognize any agreement signed by Tibet.

Until recently, the position was that no part of the northern boundary of the Indian sub-continent had been the subject of international agreement, except two small areas, Garhwal and Sikkim. Over the years, where there was actual contact between the peoples, a customary, or traditional boundary has been recognized in practice.

India, very largely on religious grounds—for many of the holy places of Buddhism lie in the mountains—has upheld

the principle that the Himalaya are the "natural boundary" of the sub-continent, while China has maintained a claim to some rights of suzerainty over their southern slopes.

In the past two years, the whole question has been brought to a head by China. By concluding agreements with Pakistan, Nepal and, on the south-east, with Burma, she has confined the controversy entirely to the boundary with India. In these agreements, China has apparently accepted the customary boundaries. Face to face with India, her largest claims are in regard to Ladakh and the North-East Frontier agency. In the latter area, India had advanced her military posts, apparently to the north of the crest line. Prior to the outbreak of the fighting in the autumn of 1962, when their forces came within striking distance of the Assam plain, the Chinese claimed the whole North-East Frontier Area, and a lesser area in Ladakh. Later, in the course of the Bandoeng Powers' mediation, China adopted a more conciliatory attitude, and has abated her claims in both areas. As far as is now known, she appears ready to accept a boundary (or at least an armistice line) which would leave her in control over the passes on the main crest line. Such a settlement, though short of her full claims, would leave her in a strong strategic position —if she should ever wish to advance on the Assam plains. In such an event, India would be at a considerable disadvantage, since her only access to Assam is by the narrow bottleneck, some twenty miles in width, between East Pakistan and Nepal.

This examination of the Indo-China conflict demonstrates several points in regard to international boundaries. "Natural" boundaries, though attractive on small-scale maps, rarely present a clean-cut solution in practice, since human geography and history intervene. A great mountain range, such as the Himalaya, however, can present a formidable barrier to military operations, and to that extent at least, serve to keep conflicting interests apart. But in the long run, determination, backed by modern technology, can overcome such obstacles. *Boundaries are only one, but by no means negligible,* aspect of political geography. In examining from a geographical point of view the standing of a nation state, many other factors must be considered: position, the nature

of its land surface, climatic advantages and disadvantages, the extent and distribution of its natural resources, accessibility to the oceans, and the structure of its population. In a later chapter, some of these are considered in relation to the Soviet Union.

CHAPTER ELEVEN

Exploration and Science in the Antarctic

IN recent years twelve nations have been engaged in scientific research in the Antarctic Continent. The intensity of this work is shown by the fact that in three years the United States Air Force have transported 5000 men to their research stations. Fifty years ago, after the *Terra Nova* expedition had left for home, this great portion of the earth's surface was without human inhabitants—a vast ice-covered area of over five million square miles in extent, separated from the other continents by hundreds of miles of stormy seas.

Why has it remained for the twentieth century to explore this unique territory, and what has prompted this contemporary activity? These will be the first questions to arise in the reader's mind; but of more interest are the further inquiries: what exactly is this Polar continent, and what part is it playing in the world today? Most of the answers to these questions can be obtained from an examination of the history of its exploration.

The Antarctic is unique in many aspects, and its early history is no exception. Unlike the American continent, the existence of which had not been foreseen by the man generally credited with its discovery, the theory of a great land-mass in the southern hemisphere had been advanced centuries before it had been sighted by European seamen—and indeed for half a century, after they had sighted the ice-pack bordering its shores, they were still doubtful as to whether or no there actually was a mainland (*terra firma*) in this area.

Greek cosmographers, from the time of Aristotle at least, had argued from analogy with the northern hemisphere, that there must be a great southern land-mass, for the principle of symmetry, dear to the Greek mind, required it. The idea persisted through the Middle Ages with the conception of the world as a sphere, which never entirely disappeared—

though for very practical reasons it attracted little attention. Medieval schoolmen continued in their textbooks on cosmography to represent the surface of the globe as containing symmetrically arranged land-masses, those in the north being balanced by equal masses in the south, where dwelt the Antipodeans. This southern hemisphere had its tropical, temperate and polar zones just as the northern lands had.

Whether these lands were accessible was much debated, but accessibility was accepted by many for theological and practical reasons. The peopling of the earth from a common centre and the injunction to carry the Gospel message throughout the world in fact required that they should be accessible. The men of the Renaissance accepted this line of thought and had their reasoning justified by the exploits of the Portuguese and those who followed in their tracks. Renaissance map-makers adopted the concept enthusiastically. Whenever a navigator reported a landfall in the far south, the cartographers hastened to present the new land as part of the mysterious continent. Their world maps show New Guinea, Tierra del Fuego, part of New Zealand and alleged landfalls in the southern Atlantic as portions of its coast line.

Its supposed area gradually shrank, the first considerable reduction being made by Abel Tasman in the mid-seventeenth century. Sailing eastwards from Mauritius and then on a general northerly course, he reduced its area by removing from it New Guinea and the much greater island of New Holland (Australia), discovering Tasmania, New Zealand and the Fiji group during his voyage. Further progress had to wait technical advances in ship construction and the science of navigation, and the establishment of adequate bases in the Southern Seas. The Dutch authorities had toyed with the idea of a giant southern maritime empire with centres in the East Indies, the southern Pacific and the Straits of Magellan, but for a century little progress was made towards solving the Antarctic problem.

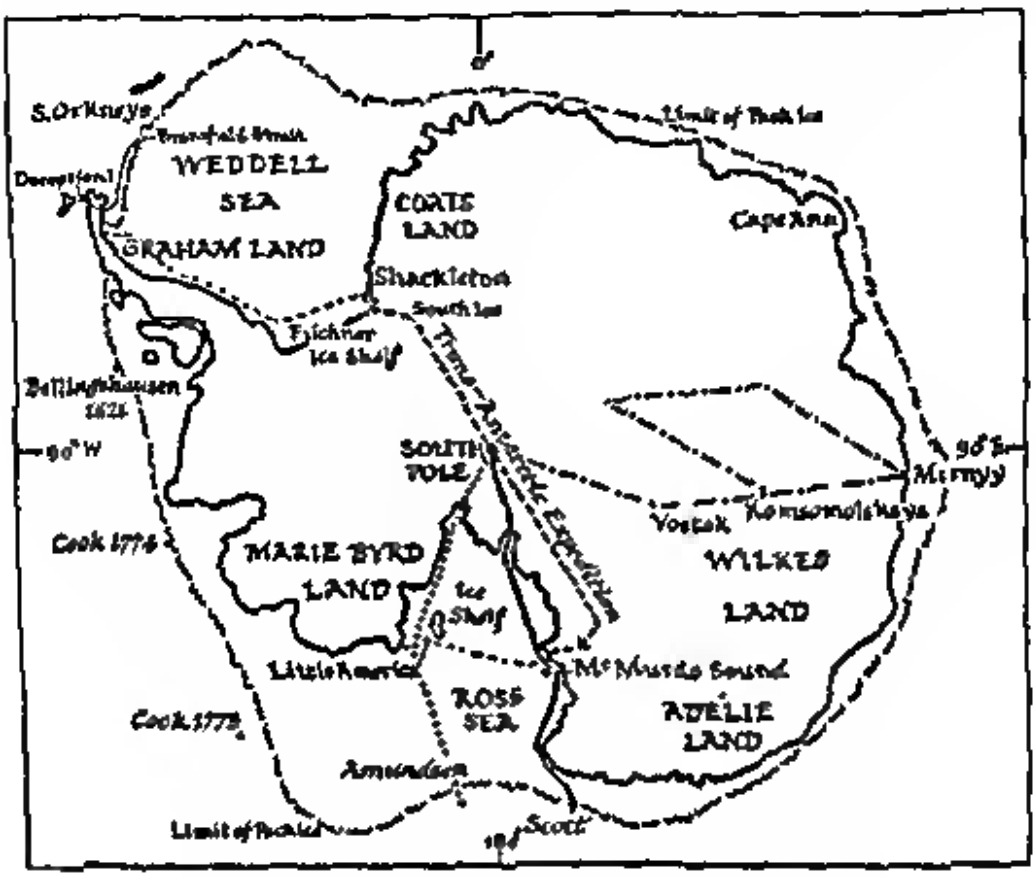
In the interval, speculation on its nature continued. Seamen, encountering icebergs in the course of southerly voyages might be sceptical of its value, but in the mind of Alexander Dalrymple, who carefully collected the theories of his predecessors, the case was altogether different. Having studied

the routes of navigators of all nations, he concluded that there was room for a great continent, extending at certain points well into temperate latitudes. Accepting the argument from analogy, he pictured this as the home of millions of inhabitants, endowed with varied resources, and worthy of the attention of Great Britain's statesmen.

This dream was shattered by the achievements of Captain James Cook. His first voyage proved conclusively that wherever else it might be, it did not extend into low latitudes in the South-west Pacific. Dalrymple, now sustained by a personal quarrel with Cook, did not abandon his contention. Cook sailed south again and removed all doubt. In the years 1772-75, he circumnavigated the continent, crossed the Antarctic Circle for the first time in history, discovered the Sub-Antarctic island groups of South Georgia and the South Shetlands, and approached closely the girdle of pack-ice at several points. The conclusions he reached are noteworthy: "That there may be a Continent or large tract of land near the Pole, I will not deny; on the contrary, I am of opinion there is, and it is probable we have seen a part of it. The excessive cold, the many islands and vast floats of ice all tend to prove that there must be land to the South . . ." This remained the accepted opinion for many years, and the Russian admiral, Thadeus Bellingshausen, reached almost identical conclusions in 1821.

On the basis of these and similar observations, the Russians regard Bellingshausen as the discoverer of the Antarctic continent, but as will be seen, this is not tenable. It can be said that the first motives in Antarctic exploration were scientific. The next impulse was economic. When Bellingshausen was off Graham Land (Western Antarctic) he encountered American sealers, attracted to these waters by Captain Cook's reports. Among them was a skipper, Nathaniel Palmer, who has since been claimed by the Americans as the discoverer of the Antarctic on the strength of his having sighted Graham Land (Palmer peninsula) in November 1820 while sailing in the waters east of Deception Island. Shortly before, Edward Bransfield, a British naval officer, had sighted land in this quarter in January 1820. The name of Graham Land was bestowed by him on this portion of the peninsula of West Antarctica.

Since he preceded Palmer by ten months, his claim seems indisputable. This kind of dispute is anyhow rather barren. Bransfield no doubt first sighted land which afterwards proved to be part of the mainland but was this so much more meritorious than, for example, Bellingshausen's sighting of



7. Antarctica, with some explorers' routes.

Alexander I island, separated from the mainland by a relatively narrow strait, a year later?

What interest these incidents have is in relation to the later history of the Antarctic. Apart from Weddell's advance into the great gulf which opposes the Ross Sea (1822), the sealers contributed little immediately to exploration. In point of fact, however, the first undisputed sighting of the mainland was by the sealer captain John Biscoe at Cape Ann in 1831.

The Antarctic was to remain unknown, or certainly uncharted, for a period, economic motives having failed of effect. It was left to science to produce the first substantial know-

ledge. The discovery by Sir James Clarke Ross in the *Erebus* and *Terror* in January 1841 of the mountains of South Victoria Land, including the active volcano of Mount Erebus, and the seaward margin of the great Ross ice shelf was the decisive incident. The motive here was to approach, perhaps even to reach, the southern magnetic pole and to obtain the geophysical observations in which the Royal Society and Alexander von Humboldt were interested.

For most of the nineteenth century, little further positive evidence of the nature of Antarctica was forthcoming. Though Ross had shown that within the enormous area behind the ice-girdle, which had been examined by Charles Wilkes (U.S.A., 1840), and Dumont D'Urville (France, 1839-40) and others, there existed mountains and bare rock surfaces similar to those already known in the Arctic, the exact extent of these and whether these areas were continuous and of continental proportions were questions still confronting geographers.

It was then clear that science would not leave them unanswered indefinitely. The results of the great *Challenger* expedition of 1872-4, though it never approached the continent closely, provided data from which the oceanographer, Sir George Murray, deduced that land of continental dimensions must lie within and under the ice. This evidence was in the form of rock fragments and abysmal ooze brought up in the nets of the *Challenger*. From their size, shape and geological character he was able to show that they were the products of erosion from a nearby continent. In his deductions Murray was certainly more fortunate than his dogmatic predecessor, Alexander Dalrymple.

Nearly half a century from Ross's voyage was to elapse before active exploration was resumed. Impetus was provided by the growing sciences of geophysics and physical geography. The resolutions of the International Polar Conference of 1879 urged the value of co-operative observations in the polar regions, but as far as the Antarctic was concerned, little was done until the International Geographical Congress in London, 1895, stimulated planning in a number of countries. Then economic motives again became interwoven with science in Antarctic exploration. As a result of developments in the whaling industry of the Atlantic and Pacific Oceans, attention

was drawn to the resources of the southern waters, and advances in whaling technique made their exploitation practicable.

It is not intended to recount once again the course of twentieth-century Antarctic exploitation. The enthralling and heroic story, with its clash of personalities and breath-taking episodes, may be read in numerous summaries. The present purpose is to indicate the significance in economics and international politics of this great surge of human activity and the place of the continent in the modern world.

The first, and certainly not the least, of the British expeditions, apart from the small pioneering effort by Carsten Borchgrevinck, was the National Antarctic Expedition of 1901-03 led by Robert Falcon Scott in the *Discovery*. This demonstrated the possibility and scientific advantages of spending two seasons in the south, and the practicability of making long sledge journeys southwards over the frozen surface. At the same time it gave sanction to procedures which were to have less fortunate results. Scott tackled the Antarctic in the tradition of the earlier naval expeditions to the Arctic. The personnel, apart from the scientists, was almost entirely from the Royal Navy. Though up-to-date equipment was provided—lighter sledges, tents and Nansen cookers—the basis was still man-hauled sledges by disciplined teams on the pattern of earlier days. Scott could never stomach dogs as a substitute for manpower, and his ponies proved unsatisfactory. The British addiction to long sledge journeys inland seems to have arisen from the fact that the topography of the Ross Sea region offered the best opportunity for such undertakings. None of the other contemporary expeditions were so favourably placed, and no comparable journeys were attempted by them. Yet the real value of both his expeditions lay in the careful planning of the scientific programme and the magnitude of the results obtained. Scott's memorial is the series of scientific monographs prepared by, or from the work of, his scientists just as much as the high standard of personal conduct and character set and maintained by him and his polar comrades. Many of the reports on a host of studies are now classics of polar science.

Ernest Shackleton, with whom Scott is now almost inevitably

linked, was of a different mould. Dispensing with conventional discipline and planning with greater flexibility—at times to a degree which appears almost rash—he was able so to inspire and lead his companions that every crisis was finally overcome. His return from his "furthest south" journey in 1908 was successful by the merest margin; his conception of a trans-polar journey in 1914 was imaginative; whether it could have been carried through is open to some doubt. It is not to denigrate Shackleton's great qualities of leadership to point out also that in comparison with Scott's, the scientific results of his journeys were meagre. In this respect, he is more on a par with Roald Amundsen, the Norwegian, whose expedition was devoted single-mindedly to the attainment of the Pole.

While the British were engaged in what had become almost exclusively the national monopoly of sledging on the inland ice, scientists of several nations—Swedes, Belgians, French and Germans—had revealed much of the topography and geology of West Antarctica.

By 1914, Antarctica was beginning to fit into the world picture, and its relationships to the neighbouring continents of South America, Africa and Australia were becoming clearer. After 1919, the modern age of intensive research began to dawn, though the dawn was slow to break. There were a number of significant trends. One resulted in the building-up in Britain of a scientific centre of Polar exploration with a growing body of experienced travellers and scientists. The links in this chain was the presence of two polar experts carrying on the Scott–Shackleton tradition, R. E. Priestley and J. M. Wordie—the training of a new generation of explorers associated with Gino Watkins' work in Greenland—their achievements on the British Graham Land Expedition of 1934-37 under the leadership of John Rymill, the only significant British work in the inter-war years—the foundation of the British Antarctic Survey (formerly Falkland Islands Dependencies Survey) in 1945, partly manned by B.G.L.E. men, and finally the most spectacular British achievement in Antarctica since Scott and Shackleton, the Trans-Antarctic Expedition of 1955-58 led by Sir Vivian Fuchs, Director of the British Antarctic Survey. This last, carrying out Shackleton's plan of 1914, crossed the inland ice from the aptly named

Shackleton Base on the Weddell Sea, to the South Pole and thence with the co-operation of Sir Edmund Hillary's New Zealand party, to the Ross Sea. Britain's share in Antarctica therefore forms a consistent and triumphant whole.

Undoubtedly the major factor in extending knowledge has been the introduction of modern technical equipment and methods—particularly the aeroplane and powered traction, and the return of the United States to the Antarctic—two closely linked developments. The first Antarctic flight was made by Sir Hubert Wilkins in Graham Land in 1928; though not sensational in achievement, it showed clearly what might be expected from aerial reconnaissance. This was further demonstrated by Lincoln Ellsworth's adventurous flight from Graham Land to the Ross Sea in 1935. The real impact was made by successive U.S. expeditions led or inspired by Admiral R. E. Byrd, from 1928 onwards. The following year he flew from "Little America" near the Bay of Whales on the Ross Ice Shelf to the South Pole, making the round flight in 19 hours. Further expeditions to the same area followed in 1933-35 and 1939-41, but the climax to Byrd's work was the U.S. Navy expedition of 1946-47, the first large scale Antarctic expedition employing all modern technological resources—thirteen ships, planes, ice-breaker and air photography. Its activities embraced most of the Antarctic coastline and extensive areas of the interior, principally in the American sector.

The scale of exploration had drastically changed from the small sledging parties of the early years of the century, and it was clear that the future lay with highly organized and powerfully equipped expeditions, backed by lavish financial resources. What could not be foreseen so clearly perhaps was the extent to which international co-operation would replace the old rivalries. The trend in this direction was shown by the Norwegian-British-Swedish Expedition of 1949-51, the first truly international venture, which spent two winters in Queen Maud Land, and demonstrated the value of techniques which were later widely employed. The tradition of sledging parties with dogs, common to British and Norwegians, was combined with the use of aeroplanes. This development is now the basis of all scientific work. Parties of scientists are flown in at the

end of the winter and carry out geophysical, geological, and survey work during the summer months, while air rescue units stand by in case of need. Stations, and field parties if necessary, can be supplied by air-drop. The United States "Scott–Amundsen" Station at the South Pole was entirely established, and is maintained, by air: so that Sir Edmund Hillary, though he found a well-equipped station at the Pole, was, in fact, the first to reach it overland since Scott and his party. All this activity culminated in the International Geophysical Year of 1959, and subsequent operations. But before glancing at its results, it will be useful to examine international developments in this sphere.

The first power to stake a claim in Antarctic territory, based on discovery and effective occupation, was Great Britain. Her interests in the Ross Sea area, and its proximity to New Zealand, led to the proclamation of the Ross Dependency in 1923, under New Zealand administration. Similarly, to control whaling in the Weddell Sea quadrant, the Falkland Islands Dependency, established in 1908, was extended in 1917. In both cases, the sector principle was employed to define the area claimed, that is all the territory within two meridians as far as the Pole. (The sector principle has been applied in the Arctic by Canada and the U.S.S.R.) Naturally other nations had their claims. Australia, particularly interested in the continent to the south, where Sir Douglas Mawson, forming a link between the heroic and scientific periods, had led expeditions at intervals from 1912 onwards, applied the sector principle on a generous scale to establish the Australian Antarctic Territories. France (*Adélie Land*) and Norway (Queen Maud Land) also have their stakes. Then the two South American countries, Argentina and Chile, have followed suit, their claims overlapping each other and the British Antarctic Territory. Their claims, as far as effective occupation goes, are not as well founded as the British, though Argentina has maintained since 1903 the meteorological station set up by the *Scotia*, for long the only station of its kind in the Antarctic.

The United States has a special place in this international imbroglio. Her interest in the Antarctic, though of relatively recent growth, is now greater than that of any other nation,

to judge at least by her investment in scientific research. Admiral Byrd proclaimed American sovereignty over the sector between the Ross Dependency and the British Antarctic Territory, but received no official support. The United States, in fact, has made no territorial claim herself, and recognizes no claim by any other nation. Her present policy is one of international co-operation, rather than national rivalry.

Nevertheless, it would be foolish to maintain that, unlike other nations, the United States has no interests at stake in the Antarctic. It is no coincidence that while maintaining a great base in Etah, North Greenland, and promoting Arctic research, she has developed extensive bases in the Ross Sea and has expended enormous sums on Antarctic research. This suggests that the whole policy is part of the defence system of the Western hemisphere, which now rests its flanks on strong supports in the north and the south. This might be said to be carrying the sector principle to its logical conclusion. It is also clear that the Antarctic is destined to play an important part in world communications. Just as the great northern airway from Europe to North America lies close to the North Pole, so the southern route from South America to Australia will lie across the Ross Dependency, and so, though with less advantages, would an air route from Australia to Southern Africa. It is not without significance that a great runway on rock is being constructed at Byrd. Since the Trans-Antarctic Expedition New Zealand is displaying much greater interest in this area, and her co-operation with the United States is close.

The present situation is based upon the Antarctic Treaty, signed at Washington in December 1959 by twelve nations actively interested therein, including the U.S.A., U.S.S.R., and Britain. The Treaty provides that the Antarctic shall be used for peaceful purposes only, nuclear weapons or explosions being specifically barred. Freedom of scientific investigation and co-operation is guaranteed, and there are arrangements for regular consultation; two such meetings have already been held, at Canberra in 1961 and Buenos Aires in 1962. Of political significance are the clauses freezing all territorial rights and claims without prejudice for the thirty years the Treaty is to run in the first instance.

This unique international understanding springs largely from co-operation in the International Geophysical Year. This, with the subsequent extension of scientific co-operation, is the coping-stone of Antarctic exploration. In all, some fifty scientific bases were established, some occupied temporarily, but others now the centres of intensive research. It was in this connection that Russia returned to the Antarctic. The U.S.S.R. carried out several remarkable journeys in the practically unexplored interior of Eastern Antarctica. The "pole of inaccessibility," that is the point furthest removed from established bases on the coast, was reached, and a temporary scientific station maintained there for twelve days in December 1958.

What has been learnt as a result of this intense activity? The Antarctic continent is an enormous mass of land ice, covering more than 5 million square miles and with approximately an average height of 6,000 feet (much greater than any other continent). This great mass, replenished by snowfall, is forcing its way outwards so that the slope to the coastline is considerable. The divide, from which the ice falls away in all directions, apparently extends from the Ross to the Weddell Seas. The climate is severe in the extreme—at no time is the temperature above the freezing-point of fresh water—and the world's "Pole of Cold" has recently been located by the Russians in East Antarctica. It is also a centre of atmospheric disturbances.

This mass of ice rests on a rock basement which in places breaks the surface and which is exposed in steep slopes, swept bare by strong winds. In patches sheltered from the wind and exposed to long hours of sunlight, small lakes may form temporarily. In similar conditions near the coast, small falls of water may also develop. The surface relief of the rock basement is gradually being revealed by geophysical soundings of the ice, which varies considerably in thickness. It is therefore probable that portions of the rock basement are below sea-level, and that were the ice to be removed, some would appear as islands.

When the ice, descending the troughs as glaciers, reaches the sea, it forms shelf ice, the seaward end of which is afloat, and from here large pieces are periodically detached to drift

away as icebergs or floes. Conspicuous areas of shelf-ice are the Ross and Filchner Ice-shelves, which owe their size to their topographical surroundings. The surface of these shelves, due to the varying pressure and direction of the ice which feeds them, are not uniformly level, and are considerably crevassed, as is also the surface of the polar plateau. Nor is the surface uniformly firm, its consistency being affected by blizzards and falls in temperature. This variation in the surface, from hard compactness to soft slush, was a major obstacle to the progress of the early explorers.

Owing to the ice cover, geological research is beset by many difficulties for exposures are few and often difficult to approach. However, a general picture of the structure and stratigraphy is beginning to emerge, though problems are manifold. The general picture is of a great Antarctic shield of basement rock (see page 94 above) forming East Antarctica, while to the west beyond the Ross and Weddell Seas is an area of intense younger folds. These folds have been related to those constituting the Andes of South America. There is considerable difference of opinion as to whether the Ross and Weddell Seas are connected by a depression, but some see here evidence of gigantic rifting, comparable to the Great Rift Valley of East Africa. The East Antarctic shield also has affinities beyond the area, since its characteristics resemble those of the Western Australian tableland. This comparability has been used to support the theory of Continental drift, it being argued that these are both portions of the ancient "Gondwana" land. It is also of interest that geologists have shown that there is no evidence of extensive glacierization earlier than late Tertiary times, and that the area enjoyed a warm climate in earlier times—another argument for continental drift. More positive is the evidence—raised beaches and the depth of the continental shelf, for example—that the land is rising relative to sea-level. There is other evidence that the ice cover is receding and it is therefore concluded that the Antarctic climate is becoming warmer. This is a fact of much interest and importance since it has been calculated that if all the ice on the world's surface were to melt completely, sea-level would rise by as much as 300 feet.

This great surface is barren of life in the interior, save for

a few species of lichen and insects. Along the coasts, life is rather richer, four species of seals breeding on the beaches. Bird life is represented by a number of oceanic species, including fulmars, petrels, terns, and particularly by the penguins, who also find nesting places where they can get ashore with ease. Only the fur-bearing seals have had any economic value, and their breeding grounds in the sub-antarctic islands attracted many sealers in the early decades of the nineteenth century.

Exploration has so far revealed few prospects of mineral resources likely to be worthy of exploitation. However, on analogies from the geology of neighbouring continents, the possibility of economically valuable deposits cannot be ruled out. Seams of soft coal have been found in east Antarctica and appreciable amounts of minerals, including uranium, gold and iron. Rich veins of quartz-pyrites also exist in the South Shetland Islands. Exploitation would necessarily be difficult, but no doubt possible through the extension of methods developed in the Arctic and the use of nuclear energy.

The economic value of the Antarctic has so far lain in the whales of the ocean. The main directions of the currents is eastwards and northwards under the influence of the prevailing winds and the earth's rotation, until they meet the warmer water of the temperate latitudes. The great interrupted sweep of the ocean, encircling the globe, the strength of the winds, and the frequency of storms make the Antarctic Ocean the roughest and wildest in the world; these have been the prime cause of its isolation throughout centuries. It was only by a very narrow margin that Scott's *Terra Nova* escaped sinking on her southerly voyage of 1910. The southern zone, where the surface temperature of the water is always close to freezing point, is covered by floating pack-ice, which is to be distinguished from the land-ice of the shelves and the tabular bergs detached from them, some of which have been reported to be a hundred miles in length. The pack moves under the influence of the winds, and is thus a major hazard of navigation.

Shackleton's *Endeavour* was crushed by the pack in the Weddell Sea in 1915, and forty years later, it was for a time

doubtful if Sir Vivian Fuchs' transcontinental expedition would succeed in penetrating the same area to reach Shackleton Base on the ice-shelf. The breaking-away of portions of the ice front has also been a hazard threatening expeditions. Many supplies of Fuchs' advance party of the previous year were lost in this way. Explorers have thus had to contend not only with the rigours of the Continent but also with the dangers of the approach by sea. It is in over-stepping the latter that the contribution of air transport has been so decisive.

Earlier in this chapter it was remarked that the Antarctic continent was unique, in that it had been predicated before it had been discovered. It is, however, unique in more ways than one. It is overlain by the greatest extent of ice in the world; it was entirely uninhabited before the arrival of European discoverers, and is practically devoid of life on its surface; from being an isolated, little known feature, it has been drawn into the modern world in scarcely more than half-a-century; it has been opened up, not primarily by international rivalry or for economic gain, but through scientific inquiry; and finally, perhaps most significantly, it is the only area of the world where international conflict has been ruled out by agreement and nuclear weapons are banned. The history of the opening up of the Americas, Africa and the Pacific region is the memorial to one stage of man's story on the earth, and it may not be too much to hope that the history of Antarctic exploration is the signpost of a new step towards a more rational employment of his faculties and resources. But to the geographer it at least demonstrates once again, in most unlikely conditions, that man is by no means the helpless prisoner of his environment.

CHAPTER TWELVE

The U.S.S.R.—a Geographical Appraisal

CERTAIN facts, it may be asserted, are widely quoted about the Union of Soviet Socialist Republics (U.S.S.R.). Perhaps the best-known relating to geography is the slogan "One eighth of the world's surface, one-tenth of the world's population." This conveys a satisfactory sense of finality, and the bare facts cannot be challenged. But, if the reader has followed one theme of this book, he should be cautious of accepting a statement of this type without thought. He should consider questions which this chapter attempts to answer as objectively as is possible: What part of the earth's surface? What kind of surface? Who are these millions of peoples and how are they distributed? How have they come to occupy it? How have they approached the geography of this vast area and what use are they making of it? It is instructive to look at the U.S.S.R. as a geographical phenomenon, without passing judgement on the social organs and methods by which its territory has been opened up and developed.

If some Arctic islands, Sakhlin, and the Kurile Islands are excepted, the territory of the Union is continuous, forming a somewhat irregular rectangle, approximately placed between the parallels of 75°N. and 50°N.—though its most southerly point is in fact in 35°N.—and the meridians 25°E. and 180°E. No other State has a continuous extent in longitude or latitude approaching this; since at least two-thirds of the coastline is not easy of access by sea, lying beyond the Arctic Circle, the Union is pre-eminently a continental unit. Many important considerations flow from this. It is a dominant factor in its climate, and has meant that the sea has never been decisive in Russian history.

From this range in latitude and longitude combined with the physical relief, it follows that there is considerable variety

in the Russian scene; from the sub-tropical environment of Baku to the extreme cold of north-eastern Siberia, where Verkhoyansk has experienced some of the lowest temperatures ever recorded (January average, −59°F.); from the shores of the Caspian Sea, 400 feet below sea-level to the glaciers and summits of Central Asia (Mt. Stalina, Tadzhikstan, 24,600 feet); from the cool damp weather of the low rolling country around Moscow to the true desert of Turkmenistan (physically and climatologically closely paralleled by plateau areas of the Sahara); and the monsoon-type conditions of the Soviet Far East. Such contrasts could be multiplied tenfold, without including the cultural contrasts from the skilled workers of Magnitogorsk to the gold-miners of eastern Siberia, and the herdsmen of the Kazakhstan steppes. Tropical rain-forest is the only major vegetation zone not to be found within the boundaries of the Union. The following pages attempt to elucidate the factors which give unity to this wealth of variety.

The broad structure and surface relief of the Union is relatively simple, the mountain margins of the south and south-east contrasting with the lowlands of the north-west and north. The pivotal points of the structure are the three regions where the basement rocks are near or on the surface (see page 94). In the north-west, where it forms part of the Fenno-Scandinavian shield, the basement is largely masked by sedimentary rocks, and the character of the surface is fashioned by the glacial cover, with its relic morainic ridges, areas of boulder clay, lakes and intricate river-network. The basement emerges again along the line of the Ural Mountains; these show themselves as a gentle swelling or low dome, much dissected, rather than as a mountain range of conventional aspect; consequently their use to delimit Europe in the east is often rejected by geographers. They serve, however, to mark the transition from the plateaux and hilly lands of European Russia to the Siberian lowland.

Siberia falls into two distinct regions—the western Siberian plain and the central Siberian plateau, divided by the general line of the Yenisei river. The western section has been described by a French geographer as the "perfect plain." The slope northwards is very slight, and the older sedimentaries are covered by thick superficial deposits of glacial and alluvial

8. Sketch-map of the U.S.S.R.

origin in the north and by the product of extensive erosion in the south. The drainage is therefore immature, in the sense that its northern direction is due to recent changes in surface level, and it is ill developed. The great rivers are sluggish, branching and tortuous; the enormous accession of water, when the spring thaw arrives, results in extensive flooding. The innumerable tributaries show similar characteristics on a smaller scale, and lakes, marsh and standing water are everywhere. The surface relief is remarkably uniform, the sole contrast being that between the general level of the land and the broad flood plains of the rivers.

East of the Yenisei, the scene changes. In the north, the basement rock again emerges as a plateau, with an altitude of 2000 to 2250 feet, and most of the area is similar in character. The eastern boundary is marked by the conspicuous troughs of the rivers Lena and Vilyuy. The general direction of the drainage is no longer south to north; in the west, the main tributaries of the Yenisei flow westwards, and those of the Vilyuy and Lena to the south-east. These thickly forested plateaux are extremely difficult of access, the only line of approach being via the narrow valleys.

Beyond the Lena, the scene again changes with the Verkhoyanski mountains and the entry into north-eastern Siberia, the ranges reproducing the arcuate pattern of eastern Asia. They are allied in structure to the "young" mountainous regions of the south, which extend from the Caucasus through the Tien Shan, the Altai and the great ranges of Central Asia. These must only be regarded as "young" in respect to the older, stable areas of the north, and to their long history of structural disturbance having continued to the Alpine phase of mountain building. In their peaks, glaciers, valleys, pamirs ("pamir" is approximately equivalent to "alp") and lakes, they present many resemblances to the Himalaya and Alps, regard being had to differences in position. This disturbed zone is one of crustal weakness abutting on the old, stable areas of Tibet and north-east China. Evidence for these disturbances are to be found along the transitional zone between these southern mountains and highlands and the northern lowlands, and some of them are clearly of relatively recent occurrence. Differential movements of level are visible in the

depression now partially occupied by the Caspian and Aral Seas.

Along the courses of the Syr-Daria and Amu-Darya—constantly shifting their beds in wide flood plains—are a series of river terraces, the highest of which is approximately 75 feet above the rivers. These indicate a fall in the base level of erosion (i.e. a fall of level in the water bodies to which the rivers flow) to which the rivers have adjusted themselves. Elsewhere there is evidence of rifting; Lake Baikal, for example, occupies a true rift valley and the lake is comparable to Lake Tanganyika in the great rift valley of east central Africa.

In the arid areas of the south-west—great expanses of fine wind or water-borne deposits—a string of "oases" extends along the foothills, provisioned with water from the ranges to the south.

If we trace the water-parting at the heads of the rivers draining to the Arctic Ocean, and add to the area thus defined a considerable proportion of Central Asia which has no outlet to the sea, the total corresponds closely to the Asian territories of the U.S.S.R. We can thus make the generalization that it occupies one of the two major physical divisions of Asia. This physical unity is reinforced by the climate, which over wide areas cannot be said to assist human activity. In general it is continental, that is, severe winters with hot short summers, the degree of cold and heat being related to distance from the sea, latitude, and altitude. Precipitation decreases from south-west to north-east, while, with reservations, the average annual temperature decreases in the same direction.

The northern coastal zone is Arctic tundra, low featureless country with little or no developed soils, carrying such dwarf vegetation as flourishes in the long hours of summer daylight. During the winter, daily temperatures below −10°C. occur on 180 days and snow lies on an average for 240 days in the year. For Siberia, conditions are scarcely less severe in certain areas. The climate has a monotonous regularity. The cold, calm winter is followed by the spring thaw and much flooding; this in turn is succeeded by a short, wet summer which becomes hotter and drier to the east and south. Within this frame, the climate of the central Siberian highlands stands

out as the most continental in type of any permanently inhabited area in the world. During the winter, stable anticyclonic weather persists, dry and very cold, with long hours of darkness. The snow cover is never continuous, since the snow drifts before the winds to pile up against all obstacles; the rivers are frozen over for six months in the year. After this monotonous period, the short summer is more variable, being hot, wet and stormy.

As was seen in Chapter VII, regional soils and vegetation are closely related to climate and the physical character and relief of the surface. In Siberia they combine to produce the group known as "podsols." Below the humus layer, these soils are poor in bacteria and mineral constituents, since the precipitation and poor drainage wash these down into the lower layers where they resolidify to form a hard impervious pan, impeding further drainage.

Much of Siberia also is in the zone of permafrost, that is, the ground below a certain level, depending upon summer temperatures, is permanently frozen—an additional bar to good drainage. The result is poor, acid, water-logged soils with much marsh on the plains, and skeletal soil or bare rock surfaces on the hill sides. The vegetational response to this is the "taiga," the vast expanse of coniferous forest, interspersed with swamps and temporary or permanent water surfaces. This somewhat gloomy picture is not entirely unrelieved. In forest clearings with locally more favourable conditions of aspect and drainage, cultivation is possible. Clearly, the amelioration of the region on a large scale will be an enormous task. In other regions of the world, roughly comparable, soils have been brought under cultivation. The high peat areas of the Netherlands are a case in point. There, in the seventeenth century, the operation comprised the removal of the peat, the breaking-up of the hard pan by digging or deep ploughing, the creation of a less-acid and better-textured soil by the addition of a proportion of sand and ash obtained by firing the vegetation cover. Drainage was further improved by ditching. Admittedly, conditions were less severe than in Siberia. The climate was milder, there was no forest cover to be removed, the area was easily accessible, and adequate supplies of labour and capital were at hand. A comparable cam-

paign in Siberia would be not merely different in degree but in kind. The present exploitable resources of the region are its timber, furs, and certain mineral resources, and their problems are referred to later.

Southwards the "taiga" gives way to the wooded steppes and then to the dry and salt steppes and the bot deserts. The steppe zone, of chernozem type soils (i.e. forest soils less highly leached and better drained than the podsols) can be described without great exaggeration as the life-line of the U.S.S.R. in Asia, since it is at once the direct and relatively unimpeded line of communication with the Far Eastern territories, the most productive area, and the base from which the exploitation of the north must proceed. Something will be said later of the role of communications in this development. Here it may be noted that, as a glance at a map will show, the great rivers of Siberia were as much obstacles as advantages to progress eastwards, since in general they flow northwards at right angles to the line of advance. The construction of the Trans-Siberian Railway was thus the decisive act in the development of Soviet Asia.

Internal migration and settlement on the southern zone of Siberia, from the Urals to Lake Baikal, has concentrated along this line. This region, about three-quarters of a million square miles in area, is probably growing more rapidly than any other in the Union. The open country recalls the traditional prairies of North America. With a longer growing period than the north (snow lying on 160 days; 120 days with average temperature above 10°C.) and some of the best soils in the south, the output of wheat, beet sugar and various fibres are important, as is cattle raising on the southern margins. However, the best soils and farms are not continuous, and much labour is attracted to the industrial centres. Of greater significance for the future, this zone is well endowed with the natural resources requisite for industrial expansion. Good-quality coal is abundant, particularly around Cheremkhovo, and lignite, used for thermal-power production, at Krasnoyarsk. Hydro-electric power is being developed on the headwaters of the great rivers in the Lake Baikal highlands. A variety of metallic ores are available, the most spectacular being the magnetic and limonite ores of the Kustanay field in the west,

the largest reserves in the country. A recent development is the steel industry at Taishet, which draws upon local supplies of iron ores and fuel. The population of this area is probably more than one-eighth of that of the entire Union, and is growing rapidly.

Some years ago much was heard of a sensational plan to transform the geography of western Siberia to advance the Soviet economy. This was generally referred to as "reversing the flow" of certain Siberian rivers, but although this was a fundamental feature, the significance of the plan is in the extent to which a whole series of geographical factors is taken into account. In brief, the project envisages the building of a great barrier dam at the junction of the Irtysh and the Ob rivers, to create a vast reservoir on the marshy lowlands. Since the fall of the land towards the north is slight, the waters of this reservoir would be directed via the Tobol river (reversing the direction of its present flow) and canals to the Aral Sea and thence to the Caspian Sea. The advantages would be (1) the control of the water of the lower Ob and the reduction of flooding in the spring—the river still being maintained as a navigable waterway; (2) the site of the reservoir would be on an unproductive area, not more than 10 per cent of which is cultivated; (3) the southern diversion would allow a great acreage in Kazakhstan to be irrigated; (4) the falling level of the Caspian Sea, partly brought about by the increasing diversion of the waters of the Volga and other affluents for industry and irrigation, etc., would be checked; (5) the creation of this great body of water might be expected to result in some amelioration of the local climate. This would be an enormous engineering operation—the barrage dam, it has been calculated, would have a length of 80 kilometres. The extent to which work has progressed is not known, but at least there are indications that the transformation is still contemplated.

Small centres of activity have been developed along the great rivers of the north, connected either with the exploitation of the forest resources or the search for minerals and oil. The bands of settlements along the upper course of the Yenisei and to a greater extent that of the Lena down to Yakutsk represent a necessary first step in the opening up of the North.

But this task is being tackled from the north as well as the south. Recognizing that the key to the north is communications, the Soviet government have for many years expended much scientific research, finance and labour on opening up the Northern Sea Route from the White Sea to Arctic Siberia. As a result, considerable settlements have grown up along the lower Ob (Novy Port, Salekhard) and Yenisei (Dudinka, Igarka) and at Khatanga, Nordvik. Life is hard here: Salekhard is on the Arctic circle, and the other ports are north of it. The tundra offers no local food resources, though fish supplies are good. Much has lately been made of the fact that in prepared and controlled conditions, it is possible to grow certain green stuffs during the Arctic summer. If cost is no object, there is no obstacle to such advances. It can provide valuable additions to diet, but does not solve the problem of supplies. What is happening here, however, is of the greatest interest to other northern countries. Nordvik, for example, is in 74°N., which is several degrees further north than Aklavik, the most northerly permanent settlement on the Canadian mainland which is in any way comparable. Etah, the military base in northern Greenland, is another 4° further north, but draws no supplies from the immediate locality. The progress of these Soviet northern settlements, of great interest to North America, is the key to the future of much of Siberia. The continuous development of the great river valleys will provide a base for lateral expansion, but there are two vital obstacles to be overcome: communications and production. Air transport, in any conceivable future, cannot meet the requirements of large-scale industrialization, and the capital cost of a rail or road network would be high. At present, apart from the lines of the Trans-Siberian Railway and its branches, the sole stretch of railroad in Siberia are the 150 miles of track between Dudinka and Norilsk. In the mountainous north-east, little development is evident, apart from the Pacific coastal areas with their milder and damper climate. There, Magadan on the Sea of Okhotsk is the outlet for a growing mining area.

It is the Russian people who have finally given unity to this vast region; through the use of natural lines of communi-

cation and the development of the railroads, they have strongly reinforced its physical unity. From the seventeenth century onwards, the Russians have, slowly at first but with increased tempo in this century, proceeded to fill this vacuum. It may be asked why, historically, culturally and demographically, there were these empty spaces for them to occupy. The answer lies, not in the related question as to why, until the mid-nineteenth century, not one of the great grasslands and steppes of the world was the seat of a stable and dynamic culture, but in the character of the second great division of Asia. In a general way, the area of Soviet Eurasia in the north-west is balanced by what may be called for convenience, but not with complete accuracy, Monsoon Asia of the south-east. Along this marine margin, the zone of contact between sea and land, and therefore of the cross-fertilization of cultures, the early civilizations from south-west Asia to China flourished, declined, and in some instances revived. With the exception of China, none of these made any significant attempt to extend their power inland, the structure of the continent to the north-west and north opposing a formidable barrier to any such project. China, on the other hand, at the northern end of this garland of cultures, at successive zeniths of her power, was well placed to outflank the Tibetan-Central Asian mountain bastion by pushing westwards. The line of her advance from the headwaters of the Hwang-ho, thence north or south of the Takla Makan to Yarkhand and Kashgar, and by a variety of routes across the Pamir and the Alai Shan, is one of the great natural corridors of Asia. In the history of Europe, its first recorded appearance is as the "Silk route" of the Romans. The vast areas to the north merging into unending forest and the long dark days of winter, remained outside the Chinese consciousness. This was indeed the "land of darkness," as alien to them as it was to the early Arab world.

Thus China moved westwards across Asia in the neighbourhood of the 40th parallel of north latitude. When Russia entered Asia, the main advance was eastwards along the 55th parallel. It would be an oversimplification to see in this an explanation of Russian-Chinese relations, but it was not until Russia at the end of her long overland trek was threatening China in the more vital Manchurian area that serious conflict

between the two powers arose. In taking possession of northern Asia, therefore, with one vital exception, the Russians were faced with the *unorganized* and *ineffectual* opposition of a few hundred thousand indigenous inhabitants. The exception was in the arid steppes of the south-west. Between the 40th and 55th parallels, the dominant power over long periods had been the nomadic horsemen, Huns, Mongols and Tartars, who at one point of time provided dynasties for China and at another threatened the emerging states of the North European plain. China dealt with them in her own fashion; Russia reached a final reckoning with them in the nineteenth century when the fabled cities of Merv, Tashkent and Samarkand passed under her rule.

This duality the Soviet constitution recognizes in a striking fashion; Siberia forms with European Russia, the Russian Socialist Federated Republic; the south-west is divided into separate Soviet Socialist Republics, Kazakh, Turkmen, Kirgiz, Ushek and Tadzhik.

Just as the contact or fusion of cultures in the south-east of Asia stimulated the growth of expanding civilizations and the Chinese advance into Asia, so the Russian advance from the north-west grew out of the blending of medieval European strains. The fundamental stock was Slavonic, with some Scandinavian admixture. The kernel, or growing point, of the Russian state was the forested region of low relief about the basins of the *Volkhov*, western *Dvina* and upper *Dnieper* rivers. With short portages, these provided a water route from the eastern Baltic and Lake Ladoga to the Black Sea and the Mediterranean. This was used in the early Christian era by Varangians and Norsemen to reach and trade with the heart of eastern Greek civilization and, until the Turkish inroads, the cultural centre of eastern Europe, Byzantium. Up the Dneiper spread in reverse, Orthodox Christianity, Greek learning and alphabet in the train of exotic trade goods. The first centre grew up on the Dneiper at Kiev, near the transition from forest to southern steppe, below the junction of the Prypiat from the west and at the junction with the Desna from the north-east. The height of Kiev's prosperity came in the thirteenth century, but was ended through its exposure to the inroads of the Tartars from the east. The embryo Rus-

sian state retired northwards, finding safety in the labyrinth of forest, river and marsh. There it continued to cohere around two centres, Novgorod controlling the northern route and so the Baltic commerce and the expanding fur trade, and Moscow. The latter was definitely the frontier post advanced towards the east, removed from the quarrels of Baltic merchants and colonizers, and estranged by religion from the Catholic Polish kingdom. The position of the city on a tributary of the Volga opened up new horizons on the Caspian Sea and beyond. Turning her back on Europe and facing eastwards, Russia began the long march across the empty continent. As the land was cleared and the trade in furs expanded, the Grand Duchy under a ruthlessly determined dynasty pushed ahead, meeting, when the Tartar threat had been defeated, with very little organized resistanee. She was also provided with a northern outlet at Arkhangelsk on the White Sea, which outflanked the Baltic trade monopolists. There a new contact was made—with the Tudor merchants seeking furs to satisfy the luxurious tastes of the court of Elizabeth I. It is a curious historical reflection that the Russian eastward advance in its early stages drew some support from this early economie link with England. But there is more significanee than this in early Anglo-Russian relations. There is a remarkable parallel in the position and evolution of the two countries in the sixteenth century. Both were young, vigorous states on the margin of Europe; drawing stimulus from their past, England from the world of Rome, Russia from that of Byzantium, but both contributing their own characteristic genius to human organization. Each was on the brink of a great leap outwards, England westwards across the ocean, Russia eastwards across the continent. While the first English colony was being established in North America, the Russian advance guard was beyond the Urals. With such differences in objective and direction no real clash of interests was to arise. In fact, with some minor exceptions, there has been no major clash, save for the blunder of the Crimea war. There has been a further common interest; with outward-looking views, the policy of both has been the rather negative one of preventing Europe from falling into the grasp of a single dominant power; on three occasions in the past

century and a half they have worked together to this end.

It is unnecessary here to describe the Russian advance across Siberia in detail. As much use as possible was made of the rivers, where their direction coincided with that of the general advance, and by 1647 Russians were on the Pacific coast. The approximate limit of expansion was determined when Chinese armies defeated attempts to secure the lower Amur valley and brought about the Treaty of Nerchinsk. It was not for a considerable time that Russia made any effort to break through or turn the southern barrier. Her defeat by Japan in 1904, when Manchuria was given up, stabilized the situation in this quarter for the time being. What is significant is the relative rapidity and uneventfulness of the conquest. In many commentaries upon this era, emphasis is laid upon the sea: phrases are employed such as "the urge to the sea," and occasionally there is a suggestion of a "race to the sea." This is to misunderstand the geographical setting and the historical circumstances. The prime object was to occupy and control a great remote natural region, and Russian policy can be seen as the resolution to take in sufficient of the mountain zone for strategic security, to throw, as it were, a "Russian wall" around Siberia, a defensive measure comparable to the construction of the Great Wall of China. The sale of Alaska to the United States in 1867, i.e. the withdrawal from the sole overseas venture, is particularly significant. It is true that from time to time, contrary policies have temporarily won support, e.g. in Persia and in the Black Sea, but it is surely more significant that they have not been pusbed to the logical conclusion.

Arising in part from considerations of Russian policy in Central Asia, a hypothesis of historical geography advanced by the Oxford geographer, Sir Halford Mackinder, attracted much attention in the first half of this century. Put briefly, he argued that (1) in the future, land power will be decisive in world affairs; (2) the greatest land area is in Eurasia, and the heart of this is the area with Arctic or continental drainage, i.e. largely the area of the U.S.S.R. (see page 180); (3) this area is being rapidly opened up by trans-continental railways and colonization, and will become a basis of power, occupying the central strategic position in the world; (4) this is the

"Heartland," dominating the "World Island," and "Who rules the World Island commands the World."

In its historical setting, this bold generalization was attractive. It took account for example, of the Russian advance into Asia, culminating in the opening of the Trans-Siberian Railway; of the increasing strain the maritime powers were experiencing in building and maintaining powerful modern navies; of the theoretical strategic advantage, i.e. the use of interior lines, which a power occupying a central position in Eurasia would possess; of the geographical theories of space and position developed by German geographers, particularly Friedrich Ratzel.

Much of Mackinder's thesis is indisputable, but some of his arguments were misconceived or have not worked out as yet in the way he foretold, and too much importance has been attached to the whole theory. Even today, with all Soviet progress taken into consideration, Siberia, as has been seen above, is far from being a developed country, and much of the remainder of the "heartland" might be more aptly described as a "dead heart." Mackinder also overemphasized the "heartland" as an area from which its nomad peoples, taking advantage of the "interior lines" had been able to threaten or overrun marginal communities. It is true that at various times these nomads have overrun Eastern Europe, the Near East, India (the Mogul Empire) and China. But to view the history of Asia exclusively from this point of view is dangerously one-sided. Much more significant for world history, has been the counter-movements and the growing power of the marginal, maritime states. The decline of the nomad world, incidentally, illustrates the long-term debilitating effects of geographical isolation and its opposite, the fertilizing and invigorating results of maritime contacts—the ocean as the life-blood of civilization. Mackinder could not be expected to foresee technological advances or their impact on world affairs. Strangely enough, for a geographer, he appears to have been misled by his maps. Had he contemplated a globe in this connection, he would hardly have placed so much emphasis on the isolation of his "world island." His rough Mercator sketch map conceals a significant factor in the global position of northern Asia *vis-à-vis* North America.

He regarded the northern coastline of the island as inviolable since it was washed by his "Icy Sea." Technological advances, particularly in aviation, have removed this fancied safeguard, and a map on a projection other than Mercator reveals a truer relationship.

Significantly, when Mackinder first propounded his hypothesis, L. S. Amery contributed a massive critique, the essence of which was that with the development of the aeroplane, "a great deal of this geographical distribution must lose its importance, and the successful powers will be those who have the greatest industrial basis." This far-sighted dictum has certainly stood the test of time. Mackinder overlooked temporarily the cardinal fact that world position (the actual position on the globe), as history has shown, is relative to the contemporary situation and technological stage. In this respect there is no inherent, eternal, geographical value, and certainly no one "world island."

Geographers who have accepted with certain reservations the essentials of Mackinder's analysis have attempted to find new heart-lands in the U.S.S.R. That certain areas have recently been developed as industrial zones in the Urals and beyond is uncontestable, but they can be accounted for without reference to the "world island" theory. After all, one Soviet aim must be the colonization of Siberia, and in modern conditions this connotes an industrial base. That, in the light of second World War experiences and later trends, location in Siberia offers certain advantages is a secondary consideration. The trend of national planning in Soviet economics, also, is now against giant concentrations. These may have possessed prestige value in the past, but experience has shown that their advantages may be outweighed by other factors—long hauls for raw materials which place strain on the communications, plus the problems of supplying a dense concentration of population, and the reverse problem of distributing the finished products. Other difficulties can also arise, e.g. water-supply, housing and similar social services.

To conclude this chapter, therefore, a brief summary of recent trends in the Soviet, with emphasis on the "growing points," is appropriate. Communications, in a country of this

9. Expansion of Russia in relation to that of Britain and the United States.

size, must have a high priority; more railway construction is probably being undertaken than in any other country in the world. The Trans-Siberian Railway, now double-tracked, has been provided with numerous offshoots, one of the most important being the Turksib line which, leaving the trans-continental railway at Novosibirsk, provides communication with the Lake Balkash region and the south-west. Another significant project is the prolongation of the Trans-Siberian from the Krasnoyarsk region to Komsomolsk on the lower Amur, which would pass Lake Baikal to the north. The railways system has also recently been linked with Pekin.

Industrially and demographically, the Soviet base is still, speaking generally, west of the Urals. Elsewhere growth is most important in the area immediately east of the Urals, discontinuously in the zone served by the Trans-Siberian rail-

way and in portions of the autonomous republics near the south-western mountain border. Except in concentrated areas, the distinction between West and East in population density is still very marked. In the central industrial region of European Russia (Moscow) and in the Ukraine, for example, it reaches 200 persons per square mile. In western Siberia the overall comparable figure is 15, and in eastern Siberia as low as 2·5. However, as has been pointed out, such figures conceal considerable variations; in the Kemerovo district, West Siberia, the density rises to 80, and around Krasnoyarsk, Eastern Siberia, to 8. It follows from these figures that large areas of northern Siberia are very scantily populated or virtually empty, save for limited areas. A number of these are on the lower course or estuaries of the great rivers; Novy Port and Salekhard on the Ob; on the Yenisei, Dudinka—Norilsk—Port Igarka. Norilsk, for a city beyond the Arctic Circle, has the large population of 108,000. These and other northern ports have been developed in connection with the Northern Sea Route, maintained in the summer from the White Sea along the Arctic coast.

Away from the coast, centres for the development of interior Siberia are expanding. An important point in this respect is Yakutsk and the upper valley of the Lena river, in an extensive coal and lignite basin, and placed to exploit the mineral-producing regions of the Central Siberian plateau and the Verkoyansk mountains. Irkutsk, an old pioneering foundation, has a population of approximately 70,000. In the Far East, the Vladivostok area and the lower Amur valley, where the town of Komsomolsk has been created, is the scene of rapid expansion, based on local supplies of coal, minerals and oil. (Vladivostok, 263,000; Komsomolsk, 177,000.)

In the south-west, the U.S.S.R. has a completely different set of circumstances with which to contend. Here it is the lack, rather than the superabundance, of water which constitutes the problem. A glance at the progress achieved in the Kazakhstan Soviet Socialist Republic will indicate its scale. The greater part of the Republic, save for the hills and mountains of the south, is lowland, hot desert and salt plains in the south, merging northwards into dry steppe and then into an area with a climate resembling that of the southern Siberian zone.

Before the Soviet period, it was a land of nomads, with a few centres of settled life in towns on central Asian caravan routes. The northern portion has been one of the centres of the recent "Virgin lands" development, where by dry-farming methods (i.e. the technique of preserving in every way the low water content of the soils, avoidance of deep ploughing, shelter-belts to protect the surface from the hot dry winds) grain production has been greatly increased. This method is admittedly extensive, rather than intensive, and yields are low, but the considerable area brought under cultivation provides a grain surplus for export. In the south, irrigated areas extend down the river valleys, where cotton and rice crops are important. But it is in industrialization that the significant progress lies. By careful prospecting, a variety of resources have been revealed. Supplies of energy are abundant in the great coal-mining centre of Karaganda and from hydro-electric installations in the south. Local supplies of ores are plentiful, so that an iron and steel industry has been established on the Karaganda coalfield, and copper and other ores are smelted. Kazakhstan, from being a sparsely populated frontier zone, eccentric to the heart of the U.S.S.R., is now being firmly integrated into the Soviet economy.

Since this chapter is concerned mainly with present-day trends in the Union and the Soviet position in Asia, little attention has been given to European Russia. Despite changes brought about by war and developments in the east, this is still the basis of Soviet power, and well over half the population is living west of the Urals. There has, however, been much development in the eastern portion, particularly in the Urals, around centres of heavy industry such as Kuznetsk (steel), Magnitogorsk and Sverdlovsk. It should also be stressed that despite large commitments elsewhere, planned regional development continues in the west. The Krivoy Rog field in the Ukraine is still the greatest iron-ore producer, and the exploitation of the Volga-Ural oilfield round Kuibyshev, the so-called "Second Baku field"—provides approximately one-half of the oil output, replacing the declining Baku supply. Other fuel supplies are obtained from the Donbas area (coal) and from north-east of the Caspian (oil at Emba).

All these regions are being closely integrated with the industrial areas around Moscow and Leningrad. Once again, therefore, there is emphasis upon communications, correlated with power production and, in the south, with irrigation. The overall plan in progress necessitates the reconstruction of the lower reaches of the Dnieper, Don and Volga rivers. Thus six dams of hydro-electric stations will remould the Volga into a great "stairway," still navigable, while a large reservoir will be established near Kuibyshev. The Volga-Don canal links the two rivers between Kalach and Volgograd (formerly Stalingrad), and extensive constructions on the lower Dnieper and Don irrigate the Crimea peninsula and the arid steppes south of Rostov.

The U.S.S.R. has been dealt with in detail to provide a concrete example of the application of geography to national planning. By western standards the scale of the operation is gigantic, but its prime interest does not lie in that aspect. In many regions the planners started, as it were, from scratch, with the advantage of being in a position to apply experience gained elsewhere to a clearly defined objective, regardless of local interests or traditional ways. In three or four decades, material standards achieved elsewhere in almost two centuries have been rivalled, though not yet surpassed. The aim, economically, has been to develop a series of regions, each to a large extent self-contained, but also oriented to supplying surpluses for the development of the others. Thus Siberia supplies Kazakhstan with timber, and Kazakhstan sends her grain surplus to the Ural industrial region, which in turn supplies both with heavy machinery, and precision tools. Theoretically, in a country of continental dimensions and a wide range of resources, and with each region becoming more closely adjusted to its environment, a complete equilibrium should be achieved. The Soviet Union, being practically self-sufficient in food and in all the resources necessary for twentieth-century industry, can proceed on her way without those considerations of supplies and markets which trouble many western nations.

In practice, it is improbable that so complicated an operation can proceed without set-backs. Apart from day-to-day

hazards, such as crop failures, the breakdown of large scale innovation through technical defects or over-optimism, there are more fundamental difficulties to be overcome. Centralization of control on this scale imposes an enormous strain on the decision-making organ, and demands a high standard of co-ordination and responsibility from top to bottom of the hierarchy. Since every contingency cannot be foreseen, a high degree of flexibility is also necessary, if failures are to be avoided.

Physically, in a country of continental size, the system throws an enormous strain on communications. There are, however, many counter-balancing advantages, economy of large scale units of production, for instance. But from a geographer's point of view perhaps the most important is the opportunity of applying geographical techniques over the whole country. The Soviet have followed this wholeheartedly, and in fact geography, in the educational system, is largely organized to this end. After graduation geographers, as all scientists must, as officials of the State, spend two to three years as members of research expeditions in the field or in working up the results for practical application. Such procedure may not be in the western academic tradition, but within the Soviet ambit it is a logical development.

CHAPTER THIRTEEN

Developing Countries in the Tropics

As has been seen in earlier chapters, there are countries at all stages of economic and social development, from those which offer their peoples little more than mere subsistence to those enjoying or at least possessing all the accompaniments of a modern highly organized industrial society. Those now usually referred to as "developing countries" (a term considered less damaging than that formerly current—"underdeveloped countries") are those in the lower half of the scale. Owing to the course of history, many of these are in Asia, Africa and South America, but this is not necessarily the case. To assess what the developing countries lack, we may therefore note the characteristic features of the industrial countries. Briefly, these are a relatively high density of population, an agriculture capable of furnishing about half of its food-supply, a highly organized industrial system, representing many years of capital investment, the application of modern technology and the labour of a body of skilled workers, access to adequate supplies of raw materials, and a world wide commercial and financial network. The possession of these has resulted in the population as a whole enjoying a high standard of living, including advanced educational facilities, and an efficient public health service. Other things being equal, these conditions result in a continuing rise of standards—an efficient industry and expanding overseas markets make more funds available for improving living conditions and for raising educational standards—hence a more effective and skilled labour force directed by better technologists, contributing to a more efficient industry, and so on. This is, of course, a theoretical conception; social, political and geographical factors may accelerate or retard the process, and so quicken or slow down the rate of progress.

An index of this progress is furnished by the material

standard of living. The fundamental factors are the movement of population (numbers, rate of growth, age categories, proportion of the sexes, etc.) and the consumption of food. If the former is growing rapidly and the consumption of food, already low, is only increasing slowly, the population will not possess the vitality necessary for national development. The root of the problem, for developing countries, is, therefore: how can food supplies be increased so that not only will the living standards of the agricultural population be raised but a sufficient margin be made available to support those engaged in the technical, educational and administrative services essential for economic advance, and for the industrial classes who must supply, among other needs, the tools for raising agricultural output. The problem is eased in many cases where the country possesses natural resource from which their own needs for raw materials can be met, and especially those which are in demand on the world market. Extreme cases are the resources in oil which have enriched the countries of the Middle East, the uranium deposits of the former Belgian Congo, the copper ore of Northern Rhodesia, and the cocoa production of Ghana. It is resources such as these which can "trigger-off" national development, by earning funds for capital investment. The position of less-favoured countries is more difficult, and the effort "to pull themselves up by their own bootstraps" must necessarily be arduous and even painful.

It is here that the developed countries can assist. The simpler method—though even this can run into difficulties and opposition—is the provision of capital funds for equipment and of markets for exports. There are however limits to what can be done in this way. It is also possible for other countries to make available their surplus food stocks—as in fact the United States has done to a quite considerable extent. But there are also limitations to such help. Wholesale redistribution of supplies could not be effected without serious, perhaps disastrous, effects on world markets. But, of more importance in the long run, such measures are in general merely palliatives. These stocks are better used in times of emergencies, for the relief of famine and other disasters. The only lasting solution is to assist the developing countries to

become self-supporting in the broadest sense. To impart all that is summed-up in the phrase "know-how" is the best service the "haves" can render to the "have-nots;" educational facilities, technical training, and specialist advice. In the end, therefore, the solution rests with the developing countries themselves. Their task admittedly is not easy: there are old prejudices to be overcome, habits and customs to be revolutionized and, in many instances, a totally new way of life to be evolved and practised with initiative and tolerance. The developing countries, it is almost a truism to state, are at the point where the western nations stood one hundred and fifty years ago. The geographer can only urge them to reflect upon the teaching of the French geographer, Paul Vidal de la Blache, and to see in their country innumerable possibilities and the opportunities for human initiative. One point to be emphasized is that the choice between continuing on more or less traditional lines or endeavouring to achieve the economic "take-off" necessary to enter the world of the twentieth century rests entirely with the individual country, though it is fair to say that few have been unable to resist pressure to move in that direction. It is not for the geographer to make the choice, but, the decision having been taken, he is qualified to advise upon a balanced plan and to warn of probable consequences of ignoring geographical considerations.

The following comments apply to developing countries in the tropics, and it is necessary to examine them from the point of view of their populations. In a general way, they fall into two main groups, long-settled areas, with dense populations and a relatively high rate of natural increase—the Indian subcontinent and the greater part of Indonesia—and the "newer" countries, less densely populated but with a rapid rate of population increase—the tropical African and South American countries. In these instances the rapid growth is largely due to the effects of preventive medicine and improved hygiene in reducing mortality rates. Parallel with these increases in population growth, the production of food has also increased —but the crux of the problem here is that the rate of increase of population is often greater than that of food production. The following approximate figures for 1959/60 (1939 : 100)

indicate the dimensions of the problem; the Far East, population, 140, food, 135; Africa, 137, 142; Latin America, 170, 165. The comparable figures for Europe are revealing: population 110, food 150. It should be added that the gap is closing in the Far East and Latin America but in recent years it has widened in Africa.

This situation is serious in itself, but there is a further consideration. Compared with world standards of nutrition, these peoples were undernourished in 1939; therefore the trend in the intervening years has been for the level of nutrition to decline. In other words, these countries have growing populations with poorer standards of living. The question of standards of nutrition is one which has raised a great deal of controversy especially when associated with arguments over the proportion of the world's population which is undernourished or actually starving. The usual course is to express the characteristic diets of various types of countries in calories a head *per diem*. One party will argue that those countries which fall markedly below the North American or West European standards are obviously underfed. Others argue that there is no proof that the nutrition requirements of a tropical population are necessarily those of the population of New York or Brussels. As there are no comprehensive studies of the tropical requirements, the problem cannot be settled by direct statistical comparisons. But there is sufficient knowledge to reach broad conclusions. It is known from reliable observations in Britain that a reduction in the total daily calorie intake by 200 calories produced a small but definite loss of body-weight in adults during the period of reduction. It is also well established that undernutrition is a powerful factor in lowering resistance to tuberculosis particularly, but also to a lesser extent to infectious diseases in general. Temporary severe periods of semi-starvation, such as natural famines, in all parts of the world, clearly produce loss of weight and reduction of physical activity and, what is perhaps equally serious, mental dullness and apathy. But, a matter of great significance, it is the quality of the nutrition not less than the quantity that is important. In tropical countries, with little variety in foodstuffs, and reliance upon cereals and starchy roots, there is a lack of vitamins and

essential mineral requirements, leading to certain deficiency diseases. Travellers in tropical countries have sometimes noted the poor agricultural standards of the native populations and have attributed this to the apathy and laziness of the cultivators. The reverse, however, is almost certainly the truth; apathy, induced by deficiency diseases, leads to poor standards of cultivation, and a vicious circle may be set up: deficiency diseases—poor cultivation—further deficiency diseases, and so on.

From these considerations it is reasonable to assume that the food output of tropical countries is too low, or at the very least, that, per head of the population, it should not be allowed to fall any lower. The following table, viewed in the light of the above, is illuminating:

PROTEIN INTAKE
Grams per head per day

	Total Protein	*Animal Protein*
Far East	52 (India)	6·9
Latin America	54 (Peru)	28·3
Europe	85 (England & Wales)	41·1
N. America	94	65·7

POPULATION AND INCOME
Per cent of world total

	Population	*Income*	$\frac{\textit{Income}}{\textit{Population}}$
Africa	7·1	2·2	0·31
Far East	52·4	12·3	0·23
Latin America	7·04	4·7	0·68
Europe	21·94	37·7	1·7

One aspect of the problem is indicated by the figures for the yields of certain crops. The discrepancies shown appear to be too great to be explained by climate and soil differences, and suggest that techniques and quality of labour must account for some proportion of them.

YIELDS, 100 KILOGRAMS PER HECTARE

	Wheat	*Rice*	*Animal Products*[1]
Western Europe	17	48	1·65
Latin America	11	16	·41
Far East	9	22	·16
Africa	6	10	·24

Before examining what can be done to improve food production in the tropics, some account must be taken of the geographical conditions. For the purpose of this chapter, the tropics are taken to be those lands with moderately high temperatures and high humidities throughout the year. These conditions occur over much of equatorial Africa, the Amazon basin and south-east Asia, though it must be remembered that variations within these divisions (micro-climates) occur locally. This régime has marked effects upon the soils, which, speaking generally, are poor, and tend to degenerate rapidly. Owing to the heavy precipitation and high temperatures, the soluble constituents—bases and nitrates—are carried away quickly. Much the same happens to the humus cover; though much organic material is deposited on the surface, particularly in dense forests, it decomposes rapidly and is likewise washed out, for soils lacking in humus are poor retainers of water. The loss of nitrogen in this way is particularly serious. This process is accelerated in bare ground, where there is more water to percolate than in dense forest.

These soils, besides being poor in quality, are also subject in the tropics to two destructive processes. Erosion on steep slopes without a cover of vegetation is particularly severe under the force of the violent outbreak of the rainy season. At other times, the bare surface may also be whipped by violent winds. The process of the "laterization" of soils is equally inimical to vegetation. A laterite soil is the end process of the leaching referred to above; it is infertile because it has lost all plant nutrients, and because, being compact and impermeable, no plants can obtain a foothold in it. Lateriza-

[1] Expressed in units combining production of milk and meat per head of cattle.

tion is most severe in hot regions with a definite wet and dry season, but can develop to varying degrees in the equatorial region of great heat and constant rainfall.

These conditions also favour a multiplicity of insects and bacteria which propagate many terrible diseases unknown in temperate regions. These are often mortal to man and beast, but even when they are not, their debilitating effects —torpor, physical weakness and mental depression—add a third element to the vicious circle of insufficient nourishment —poor resistance to infection—declining food production— further decrease in nourishment. Malaria, springing from heat and standing water, and conveyed to man by various species of the *anopheles* mosquito, with its after-effects, is the scourge of the tropics. Though much has been done to eliminate it, by destruction of the larva, drainage of swampy areas and the use of antibiotics, it remains a constant threat, liable to recur if vigilance is relaxed. There are other tropical diseases, endemic and epidemic—intestinal diseases are particularly widespread—but the main point to be made here is their relationship to low standards of nutrition.

It is often supposed that the tropics are particularly rich in supplies of timber, and thus have a valuable exploitable resource. While it is true that an exceptional number of species are present, the timber is usually soft and of little value, while the number of species militates against systematic production. Great care must also be taken in clearing forests, lest the exposed surface suffers rapid erosion. The types of forest and vegetation is often a guide to the value of the soils; but in some instances a species flourishes because it is nourishing itself upon its own fallen foliage; when the trees are removed, the inherent poverty of the soil is revealed.

Over the centuries the indigenous populations have evolved systems of agriculture which are adapted to local conditions and which, though differing in detail, have a fundamental resemblance. Their purpose is to conserve the soil and to maintain some fertility—or, in other words, to avoid lateriza-tion. The procedure is approximately as follows: a patch is chosen which, from the existing vegetation, is considered to be relatively fertile. Some trees are felled, and the bush cleared and burnt, so that the soil is enriched by the ashes,

and the surface is broken down. The net value of burning is, however, doubtful, as the fire destroys not only the brushwood but also the humus. Nevertheless, since it is a rapid method of clearance for a people armed only with primitive tools and is labour-saving, it is widely practised. The time of firing must be chosen with great care; if done too early, the brushwood is not sufficiently dry to burn easily; if too late, it will be too wet. Irregularities in the onset of the rains can therefore be damaging. The surface is little disturbed by tillage, since much hoeing or ploughing increases the risk of loss by wind or rain erosion. Sowing takes place after the first rains. A wide variety of crops are sown though one will usually predominate; for soil protection, a thick plant cover is aimed at. When the harvest has been taken, some hoeing and weeding is done if the patch is to be cultivated for more than one year. The main crop is generally rotated from year to year. After a period of from three to five years, it is abandoned, and may be left to regenerate for as long as 25 to 30 years. Large areas of former rain forest are therefore under secondary growth, or if carelessly cultivated, ruined by soil erosion. These patches, seemingly scattered haphazardly in the forest and untidily planted, appeared, not surprisingly, to early alien observers, accustomed perhaps to the neatly laid-out and carefully tended fields of the English countryside, to be convincing evidence of the laziness and irresponsibility of the native cultivators, and it was some time before the reasons for such systems were appreciated. "Shifting agriculture," as it is sometimes rather inaccurately called, bears some resemblance to the old three-field system with rotating fallow common in western Europe.

For various reasons, including restricted space in the clearings and the prevalence of killing diseases, animal husbandry was never widely practised, so that mixed farming, using animal manure, on the European model, did not develop. Refuse from the village might be spread on the clearings, but tropical conditions do not favour a rich, well-tilled topsoil. This "shifting agriculture" had certain significant results. Neglecting the question of yields, it required a relatively large area, since the "fallow" forest must also be included, per head of population. A rotation of as low as twelve

years meant that only about 8 per cent of the total was in cultivation in any one year. Since the clearings would gradually move further away from the village, time was wasted in the journey to the fields. Alternatively the village could be moved periodically to a new site, a solution which did not encourage investment of labour in domestic improvements. The density of population would therefore be low, a relatively high figure would be 30 per square mile. (At the same average figure, the population of England and Wales would be less than two million.)

Taken as a whole, the structure and the rocks of the African continent do not favour the formation of good soils. Of great age and subject to long erosion, they provide few of the necessary mineral constituents. The richer soils are from the more recent series, and have been mostly deposited in the lower valleys and mouths of the rivers. More productive areas are therefore found in the deltas and on areas of recently exposed marine sediments, as in the Gulf of Guinea. The conditions are therefore suitable for the cultivation of swamp rice, and this is now grown successfully in Sierra Leone, for example.

From what has been said, it is clear that to raise the nutrition standards and provide for the rapid growth of populations in Africa is a formidable task. The first stage is the introduction and popularization of methods leading to more intensive cultivation. The provision of more sophisticated implements, in place of the digging-stick, hoe and axe, also assist, but if the plough is widely introduced, care must be taken to avoid deep ploughing. Where applicable, contour ploughing, that is, along, not down, the slope, should be encouraged, to prevent gullying and soil erosion. Much can also be done by growing suitable green crops which can be ploughed in, thus stabilizing the soil and increasing fertility. The retention or planting of trees to provide shade and protection from the wind, also contributes to these ends, and the introduction of new crops of greater nutritive value can also help. In this connection, it is worth noting that the best food-crops in tropical Africa are introductions from America, e.g. maize and the sweet potato. The goal must be the complete abolition of shifting cultivation. In the Congo, a more rational technique has been tried out: each family clears a

limited area of forest, extending it each season. Food crops, e.g. maize, are planted first, then cotton as a money crop, then cassava and bananas together for food. The cassava is dug after two years, while the banana plants, besides yielding food, also shade young, newly-planted forest trees. In time the latter choke the banana plants, and develop into a new forest. Thus, it is hoped, in fifteen years or so the forest and the productivity of the soil will be restored: in other words, cultivation moves along a "corridor" leaving, unlike the old "shifting" method, a restored forest behind it. As for the improvement of animal husbandry, this is perhaps an even more difficult problem. The tropics in many ways are much less favourable to cattle than are the temperate regions. Thus there is a lack of well-founded traditional methods, and western scientists have much research still to do on conditions which are strange to them. However, more attention to standard procedures can do much: avoidance of overstocking, rotation of pastures, conservation of trees for shade, removal of undesirables, control of pests and wild animals, provision of watering-points, assistance in bad seasons.

Thus far, we have been considering farming in small units for local consumption. In connection with national development, the question of large-scale production of specialized crops for export will arise. The example of cocoa growing in Ghana is well-known. This is a commendable instance in that, requiring much labour, it is best cultivated on family holdings by indigenous farmers. Cultivation is not complicated, and provided it is properly conducted, does not exhaust the soil. The cocoa bean of Ghana is also fortunate in being virtually a monopoly, and thus earns valuable currency on the world market.

There is another side to the picture; the expansion of cultivation has resulted in the virtual destruction of the original forest, which was a more effective conservator of soil fertility than the cocoa plantations. Moreover, pure stands of one particular species of tree result in the propagation of a disease, "swollen shoot," which not only destroys the cocoa palm but spreads to other trees. This necessitates expenditure on research and also has repercussions on relations between farmers and the Government. Nor is the international

aspect entirely happy. As an export crop, the price of cocoa is related to the world market, and conditions, beyond the country's control, can affect its level. These effects are particularly serious when, as in this instance, the crop is a mainstay of the economy. The old adage, "Don't put all your eggs in one basket" applies with especial force. But the plight of countries which have relied on one or two main export crops which have to meet much stronger international competition, is more serious. Coffee and sugar are well-known examples. The "boom and bust" behaviour of the price of coffee has had serious effects on the agriculture of Brazil; in boom periods, a great extension of cultivation takes place with little regard for the future of the land. When the bottom falls out of the market, these plantations are abandoned, stripped of their *fertility* and devastated by *erosion*. When the price rises again, fresh areas are brought under cultivation, to undergo the same process of devastation. Yet another complication arises to affect commodities such as sugar and rubber, where their markets are susceptible to technological advances, backed by national policy—in one case, the production of beet sugar, in the other the introduction of synthetic rubber. While it would be unrealistic to expect the new countries to seek to be independent of such monocultures, they will be well advised to weigh all the circumstances carefully and to avoid the obvious errors of the past. Here again, international co-operation to regulate the world market in primary products can do much to help.

The requirements of developing countries are therefore:

(1) The gradual substitution of a more intensive, in place of extensive, agriculture; particularly through the abandonment of the various forms of "shifting cultivation," and the introduction of effective soil control.

(2) The raising of the status of the rural worker *vis-à-vis* the town-dweller or "white-collar" worker.

(3) The *balanced exploitation of all natural resources*, with the object, where possible, of renewing them, and the investment of available capital accordingly.

(4) The willingness to apply the results of scientific progress, irrespective of the country of its origin.

These may seem trite and pious expressions, perhaps even

counsels of perfection. Certainly, the obstacles to be overcome are often formidable. Questions of land reform encounter obstruction from the most deeply-seated human instincts, and traditional ways of life are not lightly to be changed. Nor can the new technology be profitably employed without an adequate educational system and efficient scientific research and advisory services. In establishing these, however, advice is available from numerous international agencies, and also not inconsiderable funds. These new countries are entering a period comparable to that facing Western Europe at the beginning of the "industrial revolution." They are at least fortunate in having some forewarning of the difficulties ahead. If westerners maintain that the future of developing countries ultimately rests with their own peoples, this is not simply from a desire to disclaim all responsibility.

CHAPTER FOURTEEN

The Future

THE preceding chapters have attempted to show how geography has advanced with discovery and exploration and with the development of the general scientific approach to the natural world. Looking at the position of the subject in the first half of the twentieth century, some geographers refer to the "new geography," in contrast to the "capes and bays" geography which was customarily taught in schools in the last century. This attitude can be justified in a limited context, but it is unfortunate if used to imply that there were no geographers before A.D. 1900, or that there is a fundamental difference between "old" geographers and new. That the contrast is made is due to the history of education in our schools and universities; much the same might be said of other subjects, history, for example, and even English literature.

To advance this point of view, however, is not to maintain that there is no difference between the outlook of a Richard Hakluyt in the sixteenth century, an Alexander von Humboldt in the nineteenth, or a Halford Mackinder in the early twentieth. These men were intensely interested in the world around them, and endeavoured to interpret it with all the equipment, intellectual and technical, at their disposal, as it appeared to them and to their contemporaries. A considerable merit of geography as an educational subject rests in this close relationship to the actual, everyday world. The real advance in geographical education was made when it ceased to be exclusively a school-room subject and became a field-study. If this link with the contemporary world should weaken, there is danger that it may relapse into a state resembling medieval scholasticism.

It may be argued that this point of view attaches too much importance to the historical aspect of geography, and that it

could lead to a reversion to the attitude of earlier centuries, when geography was generally regarded as the "handmaiden" of history. This, however, is a misconception. In the first place, it is impossible to remove the time element from geography. The demonstration of the evolution of a river system is, from one aspect, an exercise in historical thinking, and the present distribution of settlement cannot be understood without knowledge of the historical background. Conversely, no historian can give a convincing account of the history of any area without regard to its geographical characteristics. This approach is behind the at first sight paradoxical *obiter dicta* of the Russian writer, E. Tschishov: "History is the geography of the past; geography is the history of the present." Whether we subscribe fully to this or not, it is of some profit, in considering the nature of geography, to glance at what historians have written about their subject. In his stimulating *Introduction to Philosophy of History*, W. H. Walsh defines history as "a distinctive sort of thinking, called historical thinking." Up to this point, I have purposely refrained from attempting to define geography narrowly, and I think it is unnecessary to go further than the parallel definition, that geography is "a distinctive sort of thinking, called geographical thinking." In the past too much time has been spent in answering the question "What is geography?" This was largely due to what was, and to some extent, still is, the vexed question of the place of geography in the school curriculum; partly also to the desire of some geographers to establish geography as a science. No one would dispute that geography makes use of, in fact is fundamentally dependent upon, the findings of science in the special connotation of the word, just as history draws upon palaeography, numismatics and other aids. Geography, like history, resembles the sciences, in so far as it is "knowledge which is methodically arrived at and systematically related," to quote Walsh again, but, as a whole, it is not susceptible to experimental verification, nor does it formulate laws. Many examples have been given above where developments have taken place in what would at an earlier period have been considered unfavourable, or even prohibitive, conditions, and where the appreciation of geographical facts has

altered with changes in the intellectual outlook. Attempts to relate human characteristics closely to climate, for instance, have also failed.

What then is the essence of "geographical thinking"? In the first place, the geographer asks himself precisely where, within the "skin of the earth," the fact or facts which he is investigating occur. When he has established this accurately, in many cases by mapping their distribution, he proceeds to find answers to the further question: *Why there? For this* purpose, he must extend his investigations beyond the particular set of facts to all the other aspects of the environment, at that point on the earth's surface, and establish the relationship between them. At this stage he can draw upon the accumulated knowledge of other workers, and determine comparisons or contrasts with other areas. When he has satisfied himself of the relationships between the various constituents of the environment, he can then consider what process is taking place, e.g. is a certain plant association an invader, or is it failing to maintain itself, and if so, why? It may be because of the unreliability of an irregular rainfall, a fall in the water-table due to increased erosion, or the ravages of animals. The population of a countryside may be declining because the local resources which originally attracted settlement are being worked out or are being wastefully exploited—where, perhaps, a more profitable cash crop could be introduced. The locality may be too remote from a potential market, or development may be hindered by the system of land tenure. The answer may be that the amenities of a nearby town exert a strong pull on the rural population. Most probably, the final answer will be a combination of all or some of such factors.

In these and similar instances, the geographer is specializing in a limited field, and will require to have a knowledge of the allied sciences involved in these particular investigations; the important point is that he approaches the problem from a geographical point of view and uses geographical techniques. It is in the ability to proceed in this fashion that the value of a geographical training resides.

The procedures can be applied, obviously, to an area of

the earth's surface, to build up a balanced picture of its geography as a whole (regional geography), or a particular aspect can be studied as it is observed over the whole surface (general geography). At the present time, there is some danger of geographers splitting into two schools of thought—the regional geographers, who see regional interpretation as the basis of geography, and the general geographer, who rejects regional geography on the grounds that the delimitation of regions is often largely subjective and that there is no general agreement on the content of regional studies. If, however, the definition of geography as "thinking geographically" is accepted, it is possible to reconcile these differences, and regional geography and general geography can be seen as two ways, often complementary, of thinking geographically. If this is taken to represent in general the position of geography in the mid-twentieth century, what are the prospects for the study in the immediate future?

It is now commonplace to assert that the age of exploration has come to an end. This is true if exploration is regarded as it was in the nineteenth century. There are still areas of the world's surface, not in fact of very great extent individually and widely scattered, which have not been traversed on the ground and more extensive areas which have not been mapped. There are areas in which for various reasons travel is exceptionally difficult or is restricted for political or other non-geographical reasons. Many occur, as would be expected, in the polar regions or in the high mountains. It must also be remembered that in the air age, areas difficult of access on the ground have been flown over. The inland ice of Greenland has been traversed numerous times since the first crossing by Fridthof Nansen, but, as the British North Greenland Expedition of 1952-4 showed, considerable areas remain to be examined, and in the mountains of the eastern margin there are innumerable peaks and glaciers to be ascended. Similarly, though much of northern Canada has been photographed from the air for map-making, there are still routes to be pioneered, even in areas as relatively accessible as northern Quebec. The same probably holds good for the northern parts of Soviet Asia. It is only within the last forty years, for instance, that the mountains of north-eastern Siberia have

been effectively explored; but in the present condition of world politics, it is difficult to ascertain what, if anything, remains to be done there. In the far south and the Antarctic, the position is similar. Something has already been said of the exploration of the Antarctic, where the largest untraversed areas are to be found. The Antarctic and sub-Antarctic islands also afford opportunities for modern explorers. It was only in 1959 that the interior ice of Kerguelen Island was explored by Tilman; Bouvet Island lies in such stormy waters that it is often impossible to effect a landing. The extreme southern tip of South America, where the Andes are blanketed by considerable areas of inland ice, and Tierra del Fuego still offer opportunities to the adventurous mountain explorer.

The great mountain ranges of the world offer another field for the explorer. For political reasons, however, much of the Himalaya range is at present barred, at least to mountain explorers from the West. Apart from the vicinity of certain well-known peaks such as Mount Everest and Kangchenjunga, there is much to be done in Nepal, and there are "blanks on the map" of the Karakoram region. It would be profitless to attempt to examine the rest of Central Asia from this point of view. It is likely to be many years before western explorers are again admitted; indeed, in the absence of knowledge of what the nationals of the countries involved are doing, it makes little sense to look for unexplored areas there. Clearly, considerable parts of Tibet must be little frequented, particularly in the north-east, and the same applies indeed to all the rugged mountainous China-Tibet border and the country traversed by the Mekong and Salween rivers.

A natural region which still contains some unexplored areas is the great deserts. Here again it is a matter of unexplored country in the sense that it has not actually been traversed on the ground, though it may have been seen from the air. This applies to the Southern Arabian desert and to the Sahara. Much of these has been reconnoitred from the air in the search for oil, and to some extent mapped, but no doubt enthusiasts for desert travel could find scope here, provided always that political obstacles could be overcome.

As recently as 1949, Wilfred Thesiger made several pioneer journeys in the interior of Oman, and ten years later, in the western Sahara, Theodore Monod travelled extensively through little-known country.

Finally there is the vast tropical rain-forest of the Amazon basin, traversed by the great tributary streams. These are difficult to navigate but at least offer some hope of success to the explorer. The main obstacle is the fact that these forests offer the last chance of survival to the Indian tribes, exposed to disintegration and destruction through the advance of contemporary western civilization. It cannot be wondered at that these doomed peoples fail to distinguish between the *bona fide* explorer and the unscrupulous exploiters of land and people. Despite the good intentions of the respective governments, it is difficult to exclude all outside influences, or to smooth the transition from one cultural standard to another and in some ways more ruthless code. Speaking generally, what prompts the successors to the old-style explorer to seek these regions is less the opportunity to unveil geographical secrets than the desire to test his stamina and will power against physical obstacles in an extreme form—the cold and blizzards of the Antarctic, the sand-dunes, heat and thirst of the Arabian desert, the final slopes of a Himalayan peak. Allied to this is the nostalgic yearning for the company of less sophisticated peoples—an intriguing echo of the cult of the "noble savage" and nineteenth-century romanticism.

There is no need to lament the absence of fresh deserts and mountains to explore; the opportunities for the geographical explorer are, despite all the obstacles, political and others, very wide today. In place of acclaim for the discovery of a new mountain range or a hitherto unknown tribe, the reward is the satisfaction of having made a contribution to knowledge of some portion of the modern world. An achievement of this kind, however, is generally beyond the powers of a single individual, and almost certainly beyond his individual resources. The simple answer lies in team work, where scientists of several disciplines—surveyors, geomorphologists, climatologists, sociologists and numerous others—can co-operate in producing a truly geographical understanding

of a tract of country. This development is not new—an early and convincing example is supplied by Captain Scott's National Antarctic Expedition of 1901-03, and it is seen on the largest scale in the international Antarctic co-operation which has developed out of the International Geophysical Year. Operations on this scale are national undertakings, but much can be done by smaller parties spending limited periods in the field. One of the features of post-war work has been the growth of University expeditions conducted for the most part during summer vacations. It is interesting to note, incidentally, how these have to some degree grown out of the expeditions of Scott and Shackleton. From the nineteen-twenties onwards, members of these expeditions fostered at Cambridge a group of young scientist-explorers who, after experience in the Arctic, largely manned the British Graham Land Expedition, 1934-37 from which came the earlier personnel of the British Antarctic Survey, and members of this are now encouraging the spirit of exploration in British universities.

In recent years, there has been another parallel development which offers considerable scope for geographers. This is through the various agencies of the United Nations—the U.N. Economic Social and Cultural Organization, the World Health Organization, the Food and Agriculture Organization, and others. These now offer opportunities to geographers as officials or consultants to take part in international co-operative undertakings of great practical value and of fundamental importance for the countries concerned.

Something has already been said of the problems which face the new developing countries and the form which international technical assistance can take. Two specific examples of the latter may be cited here. In south-eastern Asia under the auspices of the United Nations, four countries, Cambodia, Laos, Thailand and Viet-Nam are co-operating, despite political difficulties, in collecting data for a most comprehensive scheme for the construction and operation of an integrated system of regulation works in the basin of the lower Mekong river. The ultimate aim is the establishment, through systematic use of the river-flow, of a progressive economic and social structure. This requires the evaluation of the

potential resources of the basin, starting with the river itself; the volume, seasonal fluctuations and load of the river, the areas subject to flooding, their soils and the effect of flooding upon them; the best use to which they can be put; the effect of such a project upon the life of the population and the extent to which it will require modification. Fundamental to this is the provision of maps, topographical, geological and soil, and the selection of dam sites to control the river and to irrigate the fields. At the same time, the future of river navigation must be taken into account. This project, literally a revolution for the people involved, is being forwarded by scientists from fourteen countries, who are applying techniques which have justified themselves elsewhere, and testing the possibilities of solutions which have succeeded in comparable areas in other regions. The genesis of such a project lies clearly in the Tennessee Valley Authority; should the master plan be finally carried through, the Mekong valley development will be of even greater significance than its parent. A similar operation, under the Food and Agriculture Organization, for controlling certain rivers in Afghanistan is also in progress, with a Soviet Project Manager.

The role of the geographer here is not so much to prepare, with his colleagues' assistance, a geography of the particular area but to indicate to them the specific problems they can solve and to assist in co-ordinating the answers into a master development plan. Admittedly there are major difficulties to be overcome—international rivalries and suspicions, internal political differences, cultural resistance to innovation, and financial problems. But here again, just as geography in itself does not dictate solutions, so the geographer can only investigate, formulate, advise and warn; the final decision lies with governments and peoples. In this connection the help which the national mapping agencies of the west can give to these new countries should not be overlooked. The former have learnt by bitter experience the futility and waste that arises from the piecemeal mapping of new territories, and the consequent necessity for a carefully thought-out plan for national surveys. The cartographic department of UNO, by stimulating the revision and completion of the International Million Map of the World, is also assisting in

this direction. It is fitting to recall in this connection the contribution of the British Directorate of Overseas Surveys to the mapping of the former territories in Africa and elsewhere.

At this point, it might seem paradoxical to suggest that though there is still a wide field of work for geographers and though the contribution which geographers can make is receiving increasing recognition in the international sphere, the subject is still insufficiently recognized in Britain. There are a number of contributory factors to this state of affairs. Undoubtedly, the view of the older generation, which was never taught geography intelligently, if at all, is still coloured by memories of lists of rivers, capes, towns, etc., learnt parrot-wise. For this attitude time is the only cure. In these quarters, too, the old disdain of the explorer, the administrator and the practical man for the "arm-chair" geographer is not entirely dead. This may be due in part to the geographer but the "arm-chair" geographer is surely now a mere figment of the imagination. A more recent menace has developed recently in educational circles. Here the subject is threatened at intervals with exclusion from the school curriculum or at least demotion to a subsidiary subject under the heading of social studies, or general cultural courses. It is perfectly proper to study, for example, Vaughan Williams' Antarctica symphony, but is the right place for this a project on the Polar regions?

With this general background in mind, it is not altogether surprising that the official attitude towards geography is somewhat ambivalent. War has been called the "great geographer," and there is considerable truth in this dictum. Is it so gross an exaggeration to say that, in this country, the value of geography is only fully realized in terms of military crisis? Over fifty years ago, public men of standing were protesting vigorously against the neglect of geography in the qualifications required for the higher grades of the Civil Service, the Diplomatic Service and the Army. Experiences during the war of 1914-18 led to considerable change of outlook, particularly and decisively in the educational field. It was some sign of progress that when the second world war broke out, steps had been taken to provide the organization for the produc-

tion of adequate geographical handbooks on many of the countries involved. It is of some significance that these were prepared under the aegis of the Naval Intelligence Department, and were largely written by "academic" geographers. In other ways, also, geography in common with many other sciences, made its contribution to operational planning.

The years since 1945 have seen considerable progress. This has been manifest particularly in the planning field and in the advance of its ally, cartography. The greatest official contribution to geography in the widest sense in this country has been made through the funds provided to enable the Ordnance Survey Department to provide an adequate map coverage of a high standard which meets the requirements of the planning authorities, and the central organ, the Ministry of Housing and Local Government. Certainly the latter cannot be charged with failing to recognize the contribution geographers can make to national development. But it is not without significance that, although these two official bodies have produced a series of topical maps of Great Britain on a uniform scale, the first Atlas of Britain, corresponding in scope to the numerous national atlases published abroad, has been sponsored by a University Press.

One could point to other instances of apparent official lukewarmness towards geography. Beyond maintaining their map rooms, no one of the great national libraries, as far as I am aware, has a comprehensive, separately organized geographical department, and there is certainly no national museum of geography comparable to similar museums in, for instance, Paris and Moscow. The question of government finance for research is not one which can be examined in detail here, but it can be said in general that geography tends to fall between two stools. After what has been said in earlier chapters on this aspect, it is not necessary here to labour the point that it has a unity of its own. None the less, it is difficult to secure grants for geographical research as such. Projects which can be presented as falling under the heading of "scientific," that is physical geography, climatology, etc., stand a chance of success on their merit, but those in which the emphasis is on the

human or social aspect at present attract little official support.

Despite this official attitude, the present position of geography in Britain is certainly not without hope. The contribution the geographer can make is recognized in international agencies, just as it is in certain ministries at home. It is not too much to claim however, that the recognition of its value in national planning stems to some extent from the recognition during the 1939-45 war, of the value of the Land Utilization Survey, inaugurated in the proceeding years by Dr. Dudley Stamp and carried out by him in conjunction with educational authorities throughout the country on an entirely unofficial basis. (It is, however, a curious comment on the current attitude that the Second Land Utilization Survey is now being carried out on private initiative.) There are signs that progress will continue to be made; it is heartening, for example, that the Nature Conservancy has co-operated with University College, London, in establishing a post-graduate Diploma in Conservation and Ecology in which the departments of botany, geography and zoology work together. Those taking the course are graduates in these subjects, plus agriculture and forestry. Planning is surely useless if our natural resources are to be allowed to disappear through neglect or thoughtless exploitation! A somewhat similar development, pointing to a realization of the value of adequate maps for national development, is to be seen in the establishment of post-graduate diplomas in cartography at University College, Swansea, and Glasgow University.

Geography is essentially a co-operative study, based upon an individual point of view and approach to the environment in which people live in the contemporary world. It is no reflection upon it that its practitioners may be drawn from a variety of disciplines, provided they are well-grounded in essentials. It would be foolish for them, as has sometimes happened in the past with unfortunate results, to presume to dictate to historians, anthropologists, economists or any other workers, but neither should they allow their subject to go by default. In the long run, as this book has attempted to show, a country's geography, viewed as an individual

portion of the earth's surface with its own resources and disabilities, or in relation to the remainder of the world, is not something thought up by an armchair theorist. It finds concrete expression in everyday life. Its components are not unchanging, since it is affected by revolutions in the world of technology and politics. These considerations, and the fact that it does not necessarily dictate solutions but allows of some measure of choice, surely demand that its general principles should be widely appreciated and its systematic study encouraged and adequately supported. Too often in the past its problems have been solved empirically, by trial and error, and sometimes the errors have been irretrievable. In the popular imagination geography is now associated with the exploits of hardy, but rather rash, explorers, mostly of a bygone age. Since the public is also told that the age of exploration is over, it naturally tends to think that geography is too often irrelevant to everyday life, and the development of space travel encourages this attitude. Another obstacle arises from a failure in communication; if a member of the public tries to discover what geography is about, and is faced with terms such as geomorphology, or conurbation (perfectly legitimate terms in the right context) he inclines to conclude that geography is not for him. These attitudes, combined with the "capes and bays" hangover, undoubtedly hamper the full public recognition of geography. Their refutation rests squarely on geographers.

I do not wish to end with a diatribe on the virtues, or defects, of geography today, and so conclude with a word to the ordinary reader. The time that you can give to acquiring the elements of geography will be well repaid through a heightened interest in your environment, whether at home or on holiday, in city or country. Take a map with you and after some experience, the landscape will begin to make sense to you. You will at least be in the open air and on foot! Read, too, the appropriate regional writers—Hardy for Wessex, George Eliot for the Midlands, the Brontes for the Pennines and a host of others, or study the painters or watercolourists, and your enjoyment and appreciation of the countryside will be greatly enhanced. This applies with even greater force to journeys abroad. Forget for the time being what you

have been told geography is about; if you persevere, you will discover for yourself. You will make mistakes, and learn by them. After all, you will be but following the practice of the traditional pragmatic British explorer—and geographer!

Books for further reading

THIS is not a comprehensive bibliography. The books included should help the reader to carry his studies further: I have found them useful and stimulating. They by no means represent all those from which I have profited. A few on the British Isles have been added for those who wish to know something of their own country.

General

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